AUTOMATION

JUNE 1956

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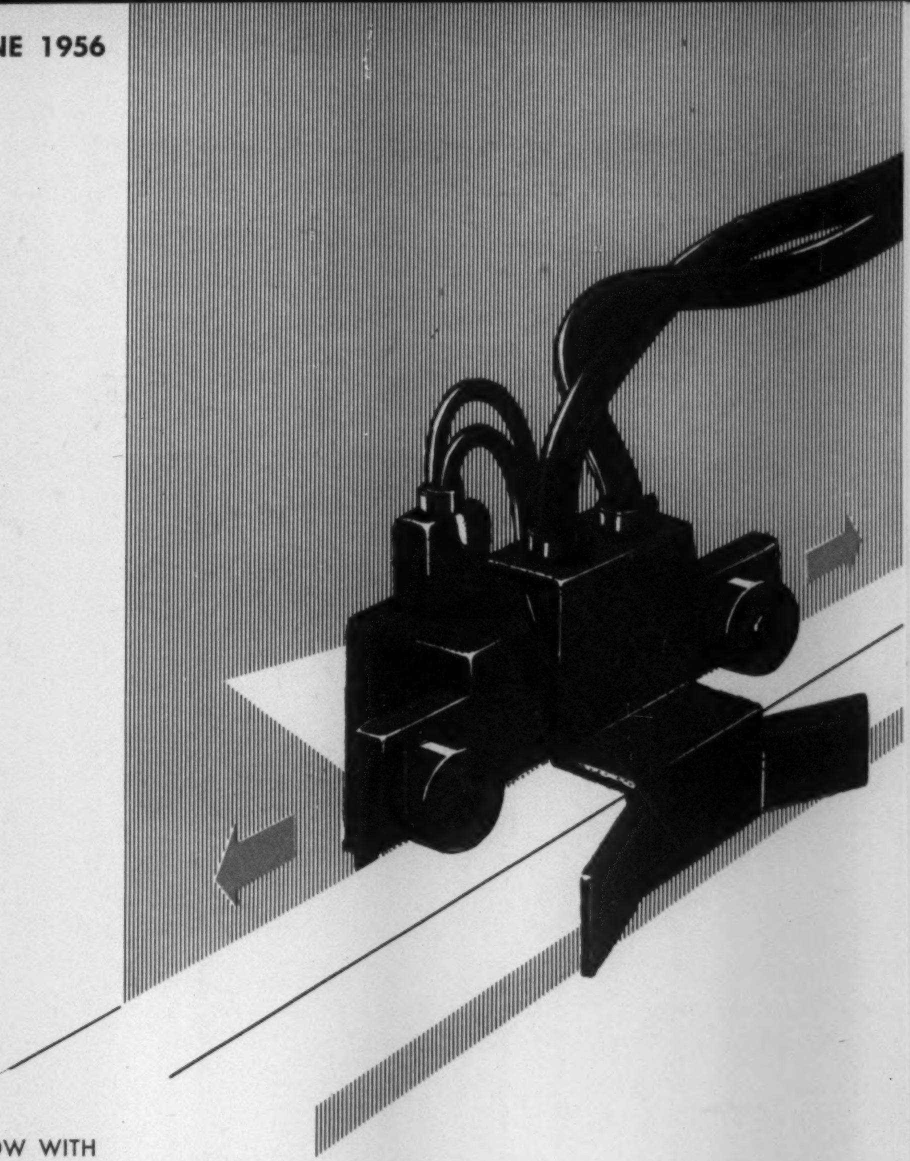

AUTOMATION RIGHT NOW WITH

Photoelectric Scanning

The Magazine of Automatic Operations

- ***Integrated Handling—Today's Trends***
- **Electronic Process Control**
- **Continuous Fiberboard Manufacture**
- **Gaging Plastic Sheet**

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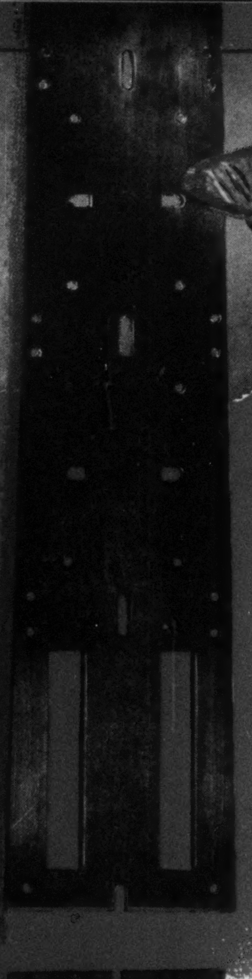
A PENTON PUBLICATION

Performance Report on the Flying Press-



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every minute [illegible] .062" gau
stock these [illegible] forme
pressed at 11[illegible]r minute
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Window channel mold
production doubled as We
Flying Press gives manuf
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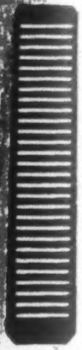
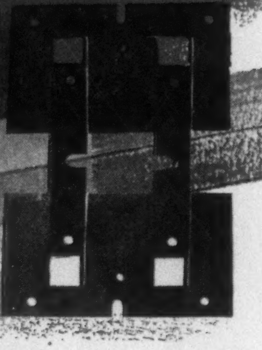




400 E's and I's every minute instead of the 180 made on slower, conventional presses.

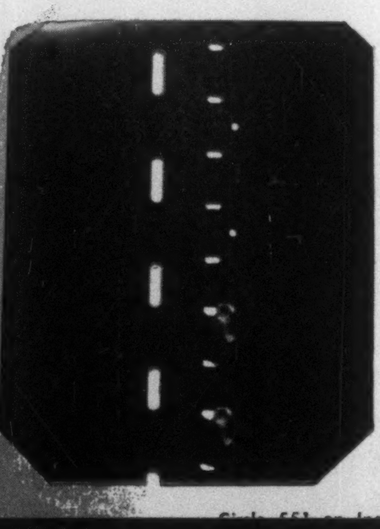
Revolutionary Wean Press continues to amaze the industry

Since it was first introduced to industry, the Wean Flying Press has commanded the interest of imaginative production people.

On paper, it looked good. Tests on the hand made prototype were even more convincing. But, could a production model achieve such levels under actual operating conditions?

For the answer—note the typical production figures set down here. In every case, the Wean Flying Press, using standard die sets, has established a performance record.

Why not acquaint yourself with this amazing press now? Contact the Wean Sales-Engineer in your area or write direct.



Shallow draw and
punch work on .06
gauge stock booste
to 400 pieces pe
minute by Wea
Flying Press.

Wean
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JUNE, 1956
Vol. 3—No. 6

AUTOMATION ®

THE MAGAZINE OF AUTOMATIC OPERATIONS

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automation outlook

COMMITTED TO AUTOMATE

". . . in the face of rising labor costs and increasing competition, both domestic and foreign, managers who wish their companies not only to survive but to prosper are firmly committed to automate as promptly and completely as current resources and present technology permit. Plant automation however, without planned, integrated material handling is not really automation at all. . ."—*Homer S. Harrison, chief design engineer, Allied Steel & Conveyors Inc. See Page* 30.

STIMULATING AND STABILIZING

". . . it is important that the public have an informed picture of the effects of automation and technological change on our national life because everyone has a personal stake in this progress. Frequently one reads statements which give lip service to the obvious benefits of automation, but go on to exaggerate the problems of adjustment until they make automation appear to be a public menace. Automation is not a menacing development. It is in fact a concept which has already raised the nation's standard of living and has had a stimulating and stabilizing effect on the economy. It will continue to have this welcome effect in the future . . ."—*Ralph J. Cordiner, president, General Electric Co.*

BETTER OFFICE TOOLS

". . . from the standpoint of management understanding of the potential value of data processing, more progress has been made in the last year than any year previous. Experience already has proved that automation of industrial operations is essential to our prosperity. Now there is growing acceptance of the fact that automation of office operation is equally necessary and can be achieved by electronic data processing systems. At Honeywell we do not look at the use of computers as an office revolution. Our belief is that office automation is simply a logical and practical extension of long-run improvement in productivity. Office automation is simply another name for better office tools that must be used if we are to hold our competitive position . . ."—*Alfred M. Wilson, executive vice president, Minneapolis-Honeywell Regulator Co.*

NECESSARY AND BENEFICIAL

". . . automation is America's hope for continuing growth in the future. Automation will increasingly serve as a general stabilizer of the economy. Automation programs require long-range, detailed planning of capital investment and the pursuit of these plans regardless of temporary ups and downs in annual sales. As automation and mechanization are introduced in a company's operations, fixed costs go up. With high investments in machinery industry has one more incentive to keep those machines running as steadily as possible. This provides a great stimulus for better planning, more professional marketing, and all the other techniques for maintaining steady demand and employment. When you couple these factors with the simple fact that the nation's appetite for goods in the next decade will rise faster than the number of people available to produce them, you can see why automation and other technological progress are necessary and beneficial, and that they exert a stimulating and stabilizing effect on our economy. . ."—*Arthur C. Studt, manager of education and training, Hotpoint Corp.*

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BPA

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AUTOMATION news

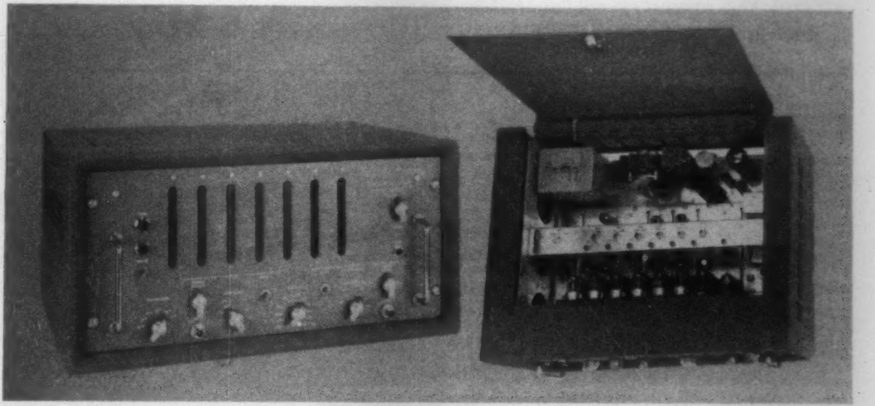
Today's events and developments in the field of automation

Standard Component Circuits Speed Instrument Manufacture

PRODUCTION techniques which have served so well in the radio and TV industries are beginning to influence the manufacture and design of precision electronic equipment. Recent announcements by several manufacturers of electronic items highlight the benefits realized from standardization of component circuits, use of modular elements, etc.

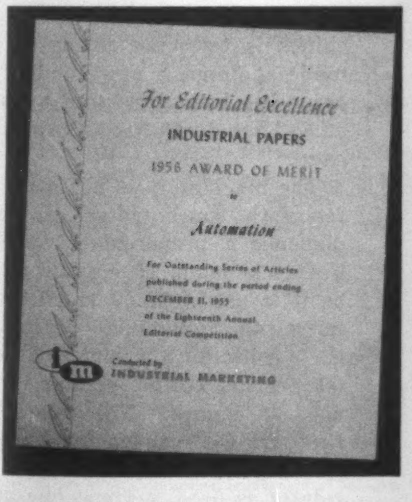
Berkeley Div. of Beckman Instruments has introduced a completely new line of equipment which includes two universal counters and timers, two EPUT meters, two time interval meters, and one frequency meter. New production techniques drastically reduce the time required to assemble the equipment.

Assembly of the various instruments is standard and identical some 85 per cent of the way to completion. During the final phases of assembly, modular variations are introduced to yield a particular instrument.



NEW line of high speed counting instruments is being manufactured by Berkeley Div., Beckman Instruments Inc. Line includes two universal counters and timers, two EPUT meters, two time interval meters and one frequency meter. Open chassis of the illustrated counter shows the uncluttered arrangement resulting from modular design. Assembly of the various instruments is identical except in the final phases where special modular variations are introduced.

The universal EPUT and timer series in the new line may be used to measure time intervals, period intervals, frequencies, frequency ratios, phase shift, as an electronic stop watch, or as a straightforward electronic counter with manual on-off control. Elapsed time over a range from 1 microsecond to 10 million seconds (116 days) can be measured. Frequency can be measured in digital form from 0 to one million cycles per second. All of the instruments can be made to operate Berkeley digital recorders, in-line readouts, or data con-



For Editorial Excellence

INDUSTRIAL PAPERS

1956 AWARD OF MERIT

to

Automation

For Outstanding Series of Articles
published during the period ending
DECEMBER 31, 1955
of the Eighteenth Annual
Editorial Competition

Conducted by
INDUSTRIAL MARKETING

AUTOMATION Wins Editorial Award

CERTIFICATE of merit has been awarded to *AUTOMATION* in the 18th Annual Business Paper Editorial Achievement Competition. Conducted by *Industrial Marketing*, the competition attracted 613 entries from the nation's business-paper field.

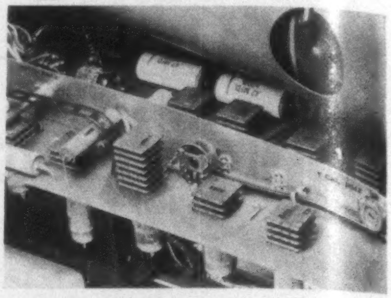
One of the five classifications of editorial material being judged involved "the best series of related articles on one theme." *Automation's* winning entry for this classification in the industrial publications grouping was "Basic Process Controls," a seven-part article by C. W. Worley (See *Automation*, April—October 1955). The award winning series stressed a basic mathematical approach to the fundamental principles of automatic control. Reader interest in the articles as they appeared originally and in subsequent reprint form emphasized their success in bridging a gap between manufacturers and users of control equipment.

In winning the award, *Automation* joins her sister publications — *Steel* and *Machine Design* — in receiving industry-wide recognition of high editorial standards — standards which characterize all of the business magazines published by the Penton Publishing Co. In this 18th annual editorial competition, out of a possible 18 awards in the industrial publications grouping, Penton entries received three plaques and three certificates.

verters to drive IBM punches, electric typewriters, teletypewriters, or analog strip chart recorders.

Another type of instrument—a digital flow indicator—has also been introduced by Berkeley. The instrument is specially designed to fill the need for a production testing instrument for calibrating flow meters and making actual flow measurements. The flow indicator utilizes the circuitry of the recently introduced EPUT meter in conjunction with a preset counter and thus shares in economies realized from the use of standardized subassemblies.

Another example of an electronic instrument which reflects a modern approach to electronic manufacture has been demonstrated by Allen B. Du Mont Laboratories Inc. The company has developed a cathode ray oscillograph which utilizes Tinker Toy design modules. Simplicity and rapidity of maintenance and repair are the major features of the oscillograph. Faulty modules are simply discarded and replaced with new ones.



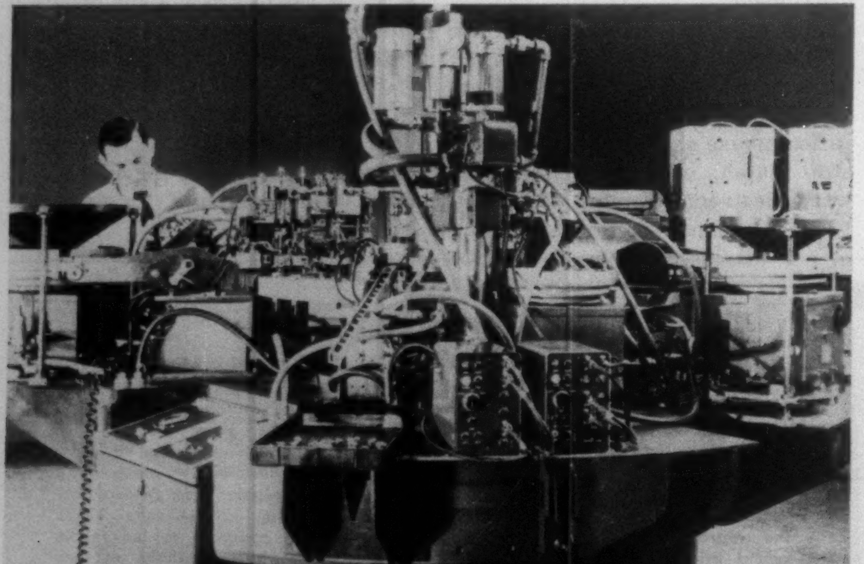
CATHODE ray oscillograph developed by Allen B. Dumont Laboratories Inc. uses ceramic wafer circuit units. In cases of failure, instruments using this method of construction are repaired by discarding the faulty modules and replacing with a new one.

Electrical Industry Urged To Explain Automation

PRESIDENT of Westinghouse Electric Corp., **Gwilym A. Price,** has charged the electrical industry with the responsibility of telling the story of automation to the American people. In a recent talk he declared, "Automation needs interpreters and defenders; and no other single American industry is so well fitted to assume this responsibility as the electrical industry." He proposed that the industry work openly to promote automation, to answer those who misrepresent it, and to explain its benefits to those who stand to gain the most from it—the American people.

Price pointed out that the electrical utility industry was a pioneer in the development and use of automation. He predicted that the change to automated production in any industry would be gradual and natural, similar to the industrial revolution. Automation is an expensive process, and industrial firms would be hesitant in scrapping huge investments in machinery already on hand.

He also stated that not enough is known to enable all of American industry to convert to automation. If a crash program were initiated without regard to cost, only about 8 per cent of the labor force would be directly affected by displacement, downgrading or upgrading. Thus it follows that in a gradual application of automation, there will be no sudden shift of workers. Where labor is displaced, it will be absorbed. Price reported, "Automation now is obviously making new jobs faster than it is displacing old jobs and old skills. More than 1000 companies are now making automation equipment. They made about 3½ billion dollars worth of it last year."

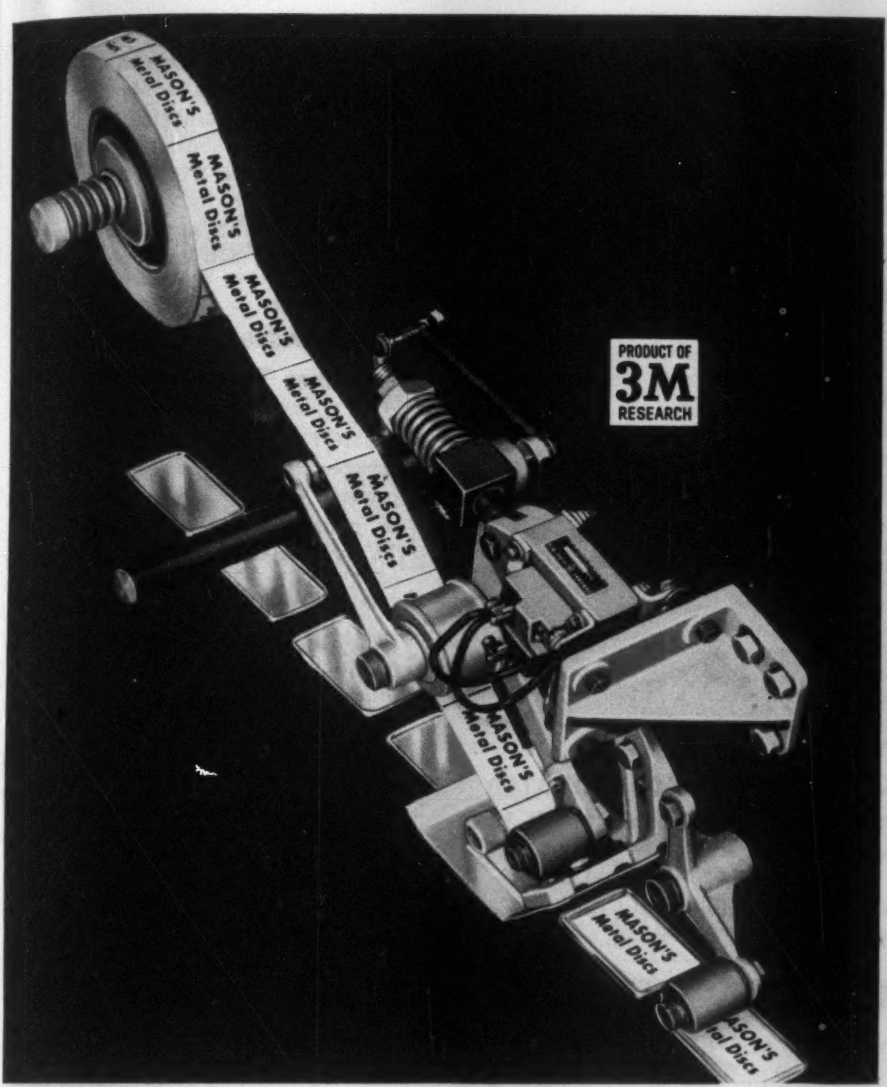


ASSEMBLY of mercury batteries is accomplished automatically on a machine designed and built by the Multra Corp., Stamford, Conn. The machine feeds, sorts, sizes, forms, orients and inspects five different battery parts. Production rate is between 15,000 and 20,000 batteries per 8-hour shift. Feedback system insures that if any part is not inserted at one of the stations, no further parts are added to the subassembly and it is rejected at a later point. Index accuracy of the 6-foot diameter work table is ± 0.002 inch.

For Fresh Coffee Addicts

WORKING on the principle that the only way to obtain homemade flavor in coffee dispensing machines is to make coffee as it is made at home, a new vending machine has been developed by Interstate-United Coffee Corp., Chicago.

The machine does not make coffee with concentrates or merely dispense a prepercolated product. Coffee is made 16 cups at a time as it is used. Each machine contains 40 individual percolators, each containing a blend of percolator grind coffee, similar to that used in homes. The capacity of the Perk-O-Fresh machine without refilling is 640 cups. As each percolator is used, a fresh one moves

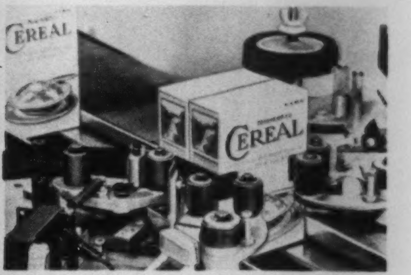


AUTOMATION?
you name it...we'll tape it!

The skeletal machine shown above is a "Scotch" Brand Flat-Surface Applicator. It automatically applies predetermined lengths of "Scotch" Brand Pressure-Sensitive Tapes to moving objects at a production-line speed of better than a unit a second. It can be used in labeling, combining, sealing, identifying, flaw-marking. This dispenser is just one of the more than 75 automatic, semi-automatic, and manual dispensers now available for "Scotch" Brand Tapes. Chances are, wherever you use—or *could* use—tapes, there's a dispenser to do the job faster, better, cheaper. Ask your regular tape distributor, or send for free booklet described at right.

DISPENSERS *for the more than 300 pressure-sensitive tapes for industry, trademarked . . .* REG. U. S. PAT. OFF. **SCOTCH** **BRAND**

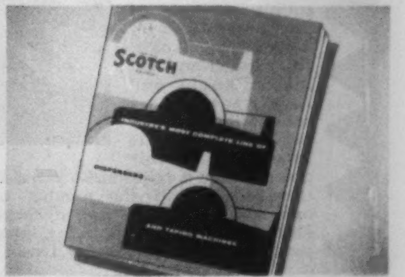
Look what you can do with dispensers!



COMBINE two or more same or different size packages; bundles and seals... all automatically. "Scotch" S-69 Sealer takes ¼" to 1" tapes wide; turns out up to 75 finished jobs a minute.

WRAP bulky bundles at production-line speed. Above: Definite-length dispensers deliver three predetermined lengths of "Scotch" Brand Filament Tape to worker with just *one* stroke of lever.

SPEED manual jobs with "Scotch" Brand Standard Job Applicators. Above: Type M Box Sealer automatically applies 1½" strip of tape to side and bottom of box as operator passes box over roller.



FREE BOOKLET illustrates and describes "Scotch" Brand Dispensers and Tape Machines. Write on your letterhead to "3M" Co., St. Paul 6, Minn., Dept. ME-66.

The term "Scotch" is a registered trademark of Minnesota Mining and Manufacturing Co., St. Paul 6, Minn. Export Sales Office: 99 Park Ave., New York 16, N.Y. In Canada: P.O. Box 757, London, Ontario.

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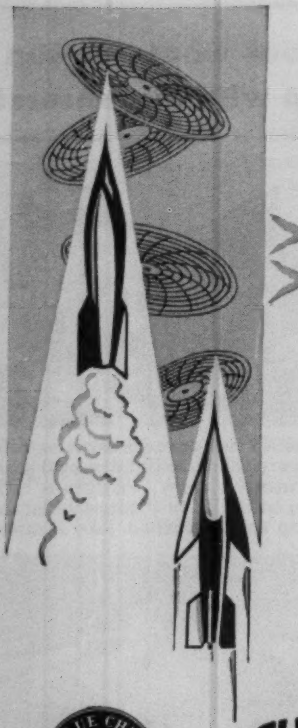

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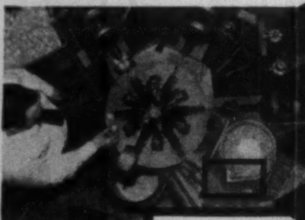
FREE DEMONSTRATION

Shows How to Cut Costs with Setko Hopper-Fed* Headless Set Screws!

How Rogan Bros. Uses Setko Method of Hopper-Feeding Set Screws in its Automation of Drilling, Tapping and Inserting



Here is a typical Setko Hopper-Feeding Set Screw installation, showing its use with special equipment designed and employed by Rogan Bros., Skokie, Ill., to drill and tap plastic knobs and insert set screws automatically in sequence. With this Setko method only one machine is required in place of three — and half the number of operators! This is one of many Setko Hopper-Feeding applications. *Mail coupon for Demonstration Details.*

This is the Setko Hopper-Feeding Special Mechanism

*Pat. No. 2,638, 945
Other Patents Pending

1429

Set Screw & Mfg. Co.
266 Main St., Bartlett, Ill. (Chicago Suburb)

We Specialize in Solving Puzzling Set Screw Problems

Set Screw & Mfg. Co. 266 Main St., Bartlett, Ill. (Chicago Suburb)

Without any cost or obligation on my part, please send me full particulars about the new Setko Hopper-Fed Headless Set Screws. (Check next line if you would like a demonstration.)

☐ I would like to have a demonstration of the special operating mechanism at your plant in Bartlett, Illinois (Chicago suburb). Please advise me how this can be arranged.

INDIV. NAME.......................... COMPANY..........................

ADDRESS..........................CITY..........ZONE...STATE..........

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into place and starts brewing 16 more cups. To insure constant freshness, unused coffee is periodically and automatically poured out into a self-contained waste receptacle. More frequent servicing is the answer to the problem if consumption at any one point is greater than 640 cups per day.

Unique Inspection System Combines TV and Microscope

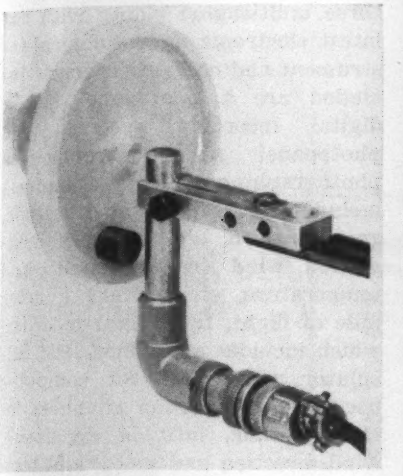
REMOTE microscopic inspection of scraper blades used in lithograph presses of the American Can Co. is possible with a closed circuit TV system installed by Radio Corp. of America.

The TV camera is installed so that it scans the blades through a microscope and projects the image, magnified 288 times, on a 21-inch television receiver. The system replaces previous practice of inspecting the blades by means of a 30-power microscope. Remote TV inspection has allowed inspectors to check twice as many blades in the same time with appreciably greater accuracy and with negligible fatigue.

The image of the blade being inspected is reproduced on the TV screen as a horizontal bar approximately four inches wide. The screen is marked with vertical lines to indicate tolerance limits. Hence the inspector is able to detect quickly any blade with irregularities which exceed the tolerance limits.

NEWLY elected president of the National Society of Professional Engineers is **R. J. Rhinehart.** A division superintendent for the Arkansas Power & Light Co., Rhinehart is in charge of engineering construction, operation and maintenance in 52 towns and cities. He has been a member of the Arkansas State Registration Board for Professional Engineers for seven years, and has been president of the board for the past three years. Rhinehart succeeds **A. C. Neff,** vice president of Armco Drainage & Metal Products Inc., as NSPE president.

The national society has also announced the election of six regional vice presidents and a treasurer. They are: **Allen H. Kidder,** vice president, Northeastern Region; **Warner Howe,** vice president, Southeastern Region; **C. A. Dunn,** vice president, Southwestern Region; **L. R. Durkee,** vice president, Western Region; **G. H. Dyer,** vice president, North Central Region; **H. G. Kennedy,** vice president, Central Region; and **R. B. Allen,** treasurer.

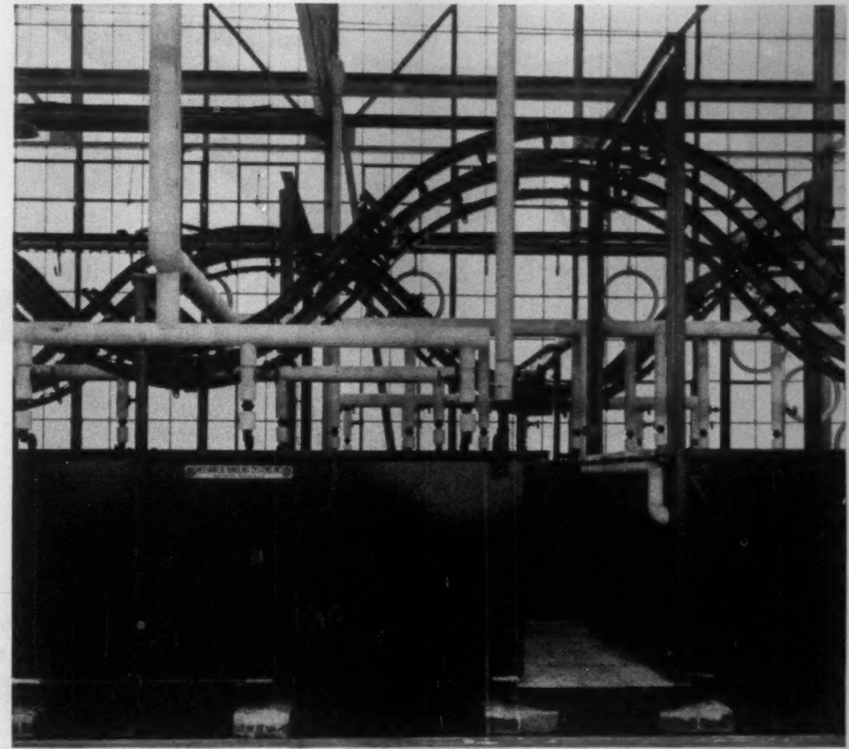


MAGNETICALLY operated high speed switch controlled by the proximity of a magnetic field has been developed by Electronic Products Div. of Post Machinery Co., Beverly, Mass. Contacts make and break in relation to magnet's proximity to face of switch. Switch can be operated at 200 cycles per second and has an estimated life of over 30 billion cycles.

Automatic Weather Station

UNENDING search for improvements in weather forecasting techniques involves the collection of basic weather data for analysis. Recent announcements point to improvements in means used to collect data.

National Bureau of Standards has developed a marine weather station that automatically reports local weather data by radio. The unit is incorporated in a buoy that can be anchored in remote locations and left unattended for periods up to 6 months. At regular intervals throughout the day, the station broadcasts in code the air temperature, water temperature, barometric pressure, and wind speed and direction. Preliminary tests show that the station has a radio range in excess of 800 miles. This type station will permit the



Automatic Pickling

on a Monoveyor roller coaster

There are several procedures for pickling steel. One is piece or batch handling. Another way is shown above, with an MHS Monoveyor curving up and down to carry work automatically through successive tanks and processing.

It's obvious which method is better. The Monoveyor requires no handling, it times immersions automatically, it maintains even production.

There are literally thousands of miles of MHS Monoveyor operating in U. S. plants today. All of it is characterized by excellent design and manufacture, long service, low maintenance, and adaptability.

Consult the MHS engineer to see how you, too, can use the Monoveyor for greater efficiency, more profitable operations.

Visit the MHS Exhibit
Booth 1015, MHI Exposition of 1956,
Cleveland Auditorium, June 5—8.

MHS

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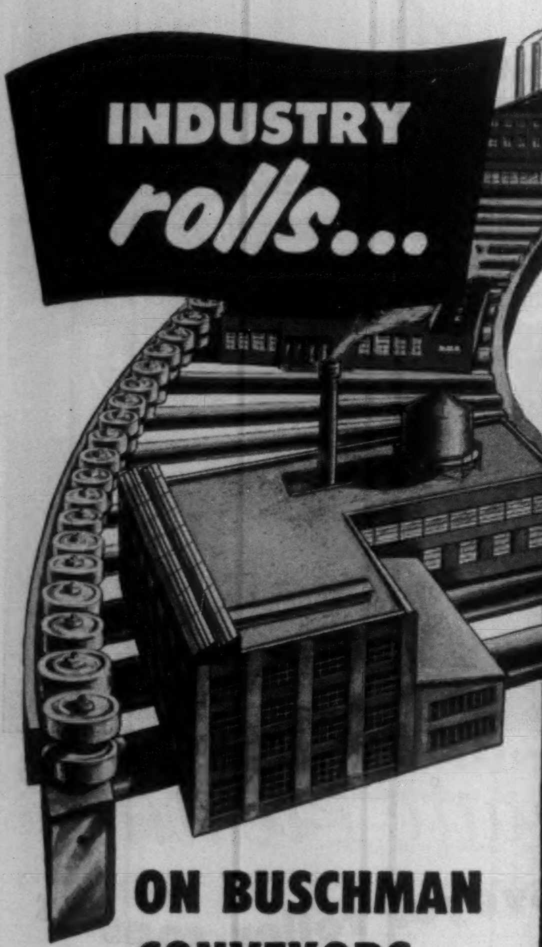

ON BUSCHMAN CONVEYORS

Across industry . . . in plants of all types . . . BUSCHMAN conveyors are setting new records for materials handling economy and efficiency. Engineered to individual production needs, these conveyor systems streamline plant operations . . . eliminate bottlenecks . . . reduce manual handling to absolute minimum.

BUSCHMAN offers a wide range of types and sizes to cover widely diversified materials handling applications. Gravity roller and wheel . . . live roller . . . powered belt . . . apron . . . overhead cable . . . or special conveyors can be supplied. In addition, BUSCHMAN engineers are prepared to survey your plant and to recommend the most practical, economical and efficient type of conveyor for each installation.

Whatever your materials handling requirements . . . specify BUSCHMAN for durable, versatile, profitable conveyor systems.

C-1733-EWB

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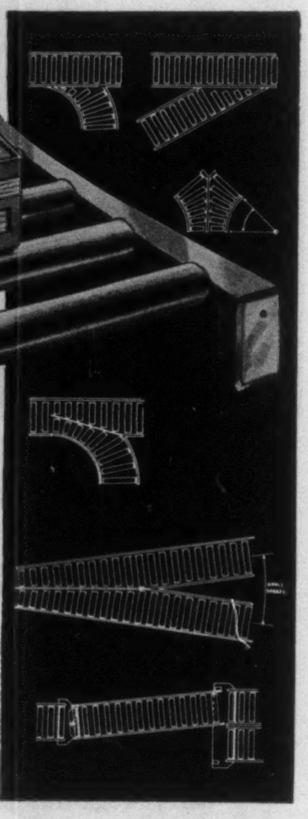
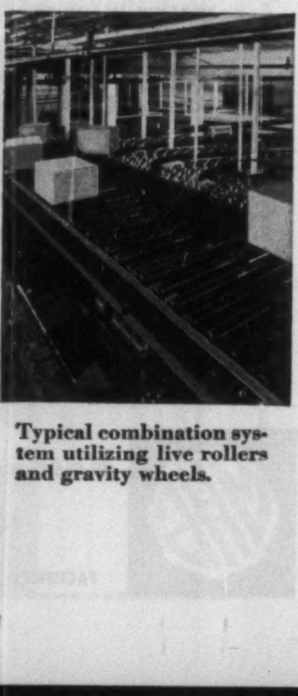


BUSCHMAN-designed switch and spur sections provide maximum versatility.



Typical combination system utilizing live rollers and gravity wheels.

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gathering of comprehensive weather data from any ocean areas outside of regular shipping lanes. Use of such stations in certain areas of the Caribbean would also give warning of hurricanes as they begin to form.

In another step in the program to learn more about hurricanes and improve hurricane forecasting methods, the U.S. Weather Bureau has awarded a contract to General Precision Laboratory Inc. to equip three multiengine planes with the latest electronic meteorological instrument and navigation gear. Included are a photopanel and a digital recording system. The photopanel permits continuous photographing of 21 data channels including time, latitude, longitude, ground speed, air speed, wind direction, wind speed, humidity and temperature, etc. Every quarter mile of flight, the digital recorder, which includes a modified IBM calculator will record for computer use nine information channels including time, latitude, longitude, wind direction and speed, and temperature. The planes containing this equipment will fly around and through hurricanes at different altitudes in collecting the data.

WAREHOUSE and distribution consulting firm, Ballinger-Meserole Co., has been retained to design the layout and operation of a 200,000 square foot distributing warehouse for Minneapolis-Honeywell Regulator Co. The depot will be used to distribute finished products and will also house certain repair and parts departments.

J. H. Binger, Minneapolis-Honeywell vice president, said the Philadelphia consulting firm was retained to "analyze our inventory and determine how much cubeage will be needed to properly house it, and to specify the handling techniques for moving it in and out."

Silvered Aluminum Bus Bars

PRACTICAL utilization of aluminum for electrical conductors, and connections with existing copper alloy materials has been announced by Federal Pacific Elec-

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Keep Up-to-Date!

tric Co. The company has developed a new process which provides an integrated surface of pure silver on aluminum bus bars. The bus is approved by the Underwriters' Laboratories for plug-in electrical connections. The process results in the replacement of surface layer aluminum crystals with those of pure silver.

It eliminates "bridging" of oxide or other surface impurities that frequently occur during electroplating. Uniform coatings of silver are obtained on the walls of drilled holes and adjacent areas where electrical connections are made. The silver surface provides ideal electrical characteristics with self-cleaning properties of the noble metals.

PACKAGED digital conversion equipment has been designed by Hanson Gorill-Brian Inc., Glen Cove, N. Y. for Minneapolis-Honeywell Series 156 circular scale indicators. The auxiliary equipment is contained within the original instrument housing. Decimal digit output data are suitable for direct input to an IBM summary punch, electric Clary printer and similar devices.

Circuit Testing Device Prevents Breakdowns

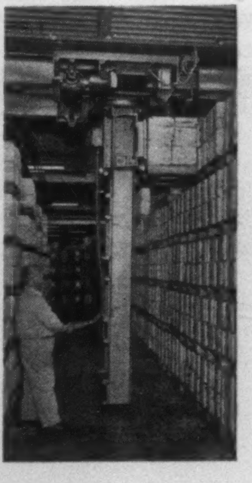
FAULT locator has been developed by Commonwealth Engineering Co. of Ohio for the U. S. Air Force. The unit is capable not only of locating points of breakdown, but also of identifying these points before components fail or act erratically.

Essentially, the new device sets up a comparison circuit for checking against operating equipment. When this electrical circuit varies from the set standard, the trouble is automatically located. As the unit does not use vacuum tubes, possible errors in the device are eliminated, particularly when checking vacuum tubes and transistors in circuits.

How much of your storage space has melted away due to old-fashioned handling methods?

TAKE FULL ADVANTAGE OF THE CUBE — STORE IN AISLE SPACE — TRAK-RAK **utilizes** aisle space—requires a very narrow aisle only 2 ft. greater than pallet size—revolves a full 360° to service both sides. Average industrial trucks must have 10 ft. to 12 ft. aisles for maneuvering and placing. **Make this extra aisle space, storage space!**

STORE CLOSE TO CEILING—TRAK-RAK stores within inches of ceiling—operates on overhead crane rails—utilizes maximum of cube—stable at all heights. The lift of average industrial truck is limited; the higher the lift, the more aisle space required and the less stable the load. **Make this waste upper space, storage space!**



TRAK-RAK IS 1-MAN PENDANT PUSH-BUTTON CONTROLLED from the floor, is 100% selective in placing and removing materials, and can be installed in practically any type of storage building without building alterations. Can be furnished as a self-contained unit running on top of the racks or as an underhung crane system. **Make use of ALL present storage space.**

WRITE FOR TRAK-RAK APPLICATIONS—a 20 page illustrated booklet explaining in detail TRAK-RAK Handling and Storage Systems and giving complete information on 14 widely different TRAK-RAK Installations.

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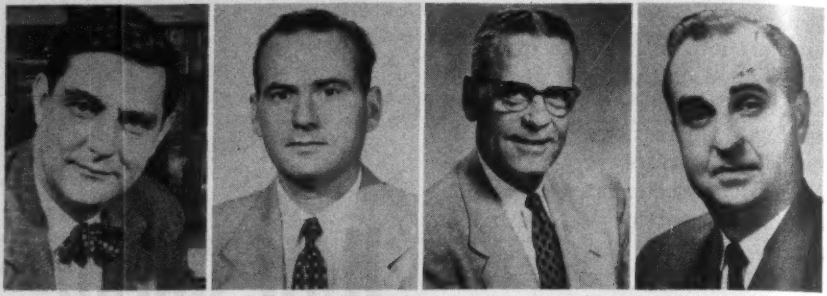
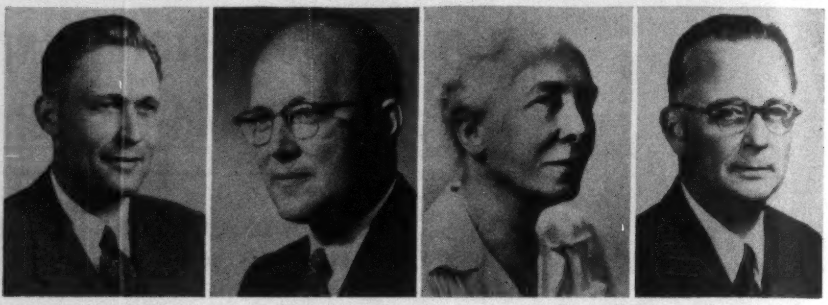
Technical Sessions Program Accompanying AMHS Exposition

Technical Session Speakers, Tuesday, June 5—Ovens, Apple, Mogenson, and Raymond.


Technical Session Speakers, Wednesday, June 6—Gardner, Briggs, Warner, and Barkdoll.


Technical Session Speakers, Thursday, June 7—Shimp, Bright, Gilbreth, and Maynard.

MANAGEMENT aspects of material handling are to be featured at the technical sessions sponsored by American Material Handling Society in conjunction with the Material Handling Exposition to be held in Cleveland June 5 through June 8.

Scheduled speakers and program topics are: **E. A. Ovens,** Academy of Advanced Traffic, *Traffic Management and Material Handling;* **James Apple,** Michigan State University, *Relationship of Plant Layout to Material Handling;* **A. H. Mogenson,** Work Simplification Conferences, *Work Simplification and Its Use in Material Handling;* **George G. Raymond Jr.,** President, The Material Handling Institute Inc., *Management and Material Handling;* **F. V Gardner,** Fred V. Gardner Associates, *Analyzing Material Handling Costs;* **A. J. Briggs,** head of Material Handling & Warehousing Branch, Navy Bureau of Supplies & Accounts, *A Simplified Approach to Stock Positioning and Space Control;* **W. D. Warner,** Sears, Roebuck & Co., *Distribution in Relationship to Material Handling;* **Grover Barkdoll,** Methods Engineering Council, *Operation Analysis in Material Handling;* **J. W. Shimp,** Marinette Paper Co., *Paper Mill Management Looks at Material Handling;* **J. R. Bright,** Harvard University, *Managerial Problems Arising Out of Automation;* **Dr. Lillian Gilbreth,** Knapp Visiting Professor, *The Relationship of Industry to Education and Training;* and **H. B. Maynard,** Methods Engineering Council, *Work Measurement and Material Handling.*

MEETINGS AND EVENTS

June 11-15—
Society of the Plastics Industry Inc. Seventh national plastic exposition to be held Coliseum, New York. Additional information may be obtained from Society Headquarters, 65 West 44th St., New York 36, N.Y.

June 11-15—
Pennsylvania State University. Small plant automation seminar to be held University Park, Pa. Additional data may be obtained from Extension Conference Center, Pennsylvania State University, University Park, Pa.

June 11-29—
Case Institute of Technology. Summer study course in process control theory with frequency techniques to be held Cleveland campus. Additional information may be obtained from Graduate Div., Case Institute of Technology, 10900 Euclid Ave., Cleveland 6, O.

June 12-15—
Cornell University. Annual industrial engineering seminars to be held Ithaca, N.Y. Additional information may be obtained from Dept. of Industrial & Engineering Administration, Cornell University, Ithaca, N.Y.

June 17-22—
American Society for Testing Materials. Annual meeting and apparatus exhibit to be held Chalfonte-Haddon Hall, Atlantic City. Additional information may be obtained from R. J. Painter, 1916 Race St., Philadelphia 3, Pa.

June 18-22—
Human Engineering Institute. Fourth annual institute conducted by Dunlap & Associates Inc. to be held Stamford, Conn. Additional information may be obtained from Dr. L. W. Thomas, Dunlap & Associates Inc., 429 Atlantic St., Stamford, Conn.

July 9-20—
Purdue University. Short course in linear automatic control system synthesis to be held Lafayette, Ind. Additional information may be obtained from Div. of Adult Education, Engineering Administration Bldg., Purdue University, Lafayette, Ind.

AUTOMATION NEWS FEATURE

Industry Views . . . .

Integrated Handling

The Vital Link In Automation

SO FAR AS material handling is concerned, the ideal condition in manufacturing and distribution would be no handling at all. The ideal is obviously unobtainable, but a modern concept expresses an approach to the problem which most closely approximates the ideal—that concept is integrated handling. It is a term with a variety of meanings.

In automation, the term, when used in a precise sense, refers to handling operations which have been carefully engineered as a part of an overall plan which considers the relationship of handling to the design of the product and to the production process. The value of this approach to handling in automation is self-evident, since it embodies the concept of including in the design of the product those features which will result in superior handling characteristics needed for automatic operations. Some of the more spectacular advances made in the area of automation have followed the recognition of the importance of an integrated handling function. Current discussion concerning the use of standard handling equipment versus the use of specially designed equipment reflects the widespread acceptance of the main principle of integrated handling. The argument is not "if to integrate" but "how best to integrate."

Unsuitable in automation, concepts such as merely increasing speed of movement, or handling increased quantities, or exerting less manual effort are satisfactory approaches to material handling problems for simple mechanization. The real gains which have been realized by isolated attacks on individual areas of inefficiency cannot be minimized. Indeed, in that economics limit the area of application of automation techniques, there will always be a need for just this approach to various material handling operations.

Far from replacing such equipment as industrial lift trucks, cranes, unpowered conveyor applications, etc., increased automation can be expected to add to the demand for these items as industry strives to balance out discrepancies in inefficiency between the automated and all other operations. And, for maximum efficiency handling equipment in isolated applications would certainly need to be integrated in accordance with some overall plan.

Thus, integrated handling is as relative a term as is automation, but some idea of the importance of the basic philosophy to all industries can be gained from the pictures and comments in this special section. All of the authors are men of note in the material handling field, and write from experience and knowledge gained in furnishing handling equipment to a broad segment of American industry.

Integrate Handling With Standard Tools

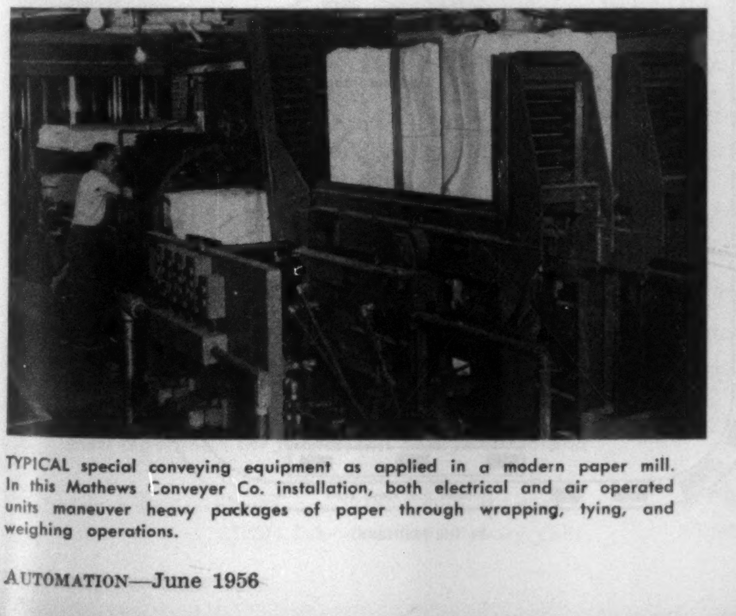
By J. R. MITCHELL
General Manager
Service Conveyor Co.

PRIME FACTOR in obtaining automation, Detroit mechanization, flow of production, mass production, or work-flows with feedback mechanisms is the mechanization of handling. The conveyor is the basic element for handling and, therefore, the conveyor is the integrating factor and vital link in automation.

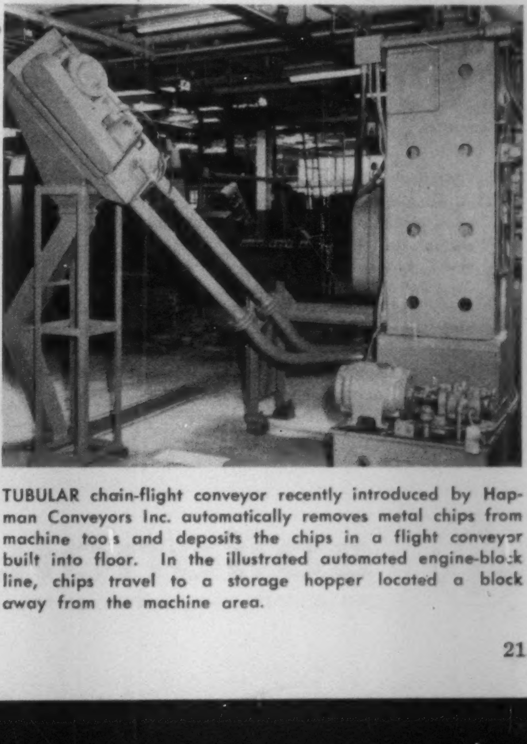
Management should take a searching look at the conveyor if interested in achieving automatic processing, remembering that the objective is always the most economical level of mechanization rather than mechanization for its own sake. Developments in conveyors in the past few years have turned abstract ideas into realities; but those who have turned the engineering feat have not sold the buying management group. The sale point is obvious.

For example, the manufacturing executive pressed for funds to profitably produce must ultimately realize that new automated, single-purpose, inflexible machine tools at high capital investment cost are an imprac-

INTEGRATED HANDLING• • • • • • • • • • • • • • • • • •



TYPICAL special conveying equipment as applied in a modern paper mill. In this Mathews Conveyer Co. installation, both electrical and air operated units maneuver heavy packages of paper through wrapping, tying, and weighing operations.



TUBULAR chain-flight conveyor recently introduced by Hapman Conveyors Inc. automatically removes metal chips from machine tools and deposits the chips in a flight conveyor built into floor. In the illustrated automated engine-block line, chips travel to a storage hopper located a block away from the machine area.

tical and uneconomical solution to his problem of mechanization. Also, the spectre of obsoleting unamortized standard machine tools and equipment for single-purpose automated equipment is equally unappealing. Further, the executive who makes the decision to install single-purpose automation equipment commits the company to a relatively rigid production system both from a manufacturing and a sales position. Conversely, a battery of general-purpose machines linked with an integrated handling system (conveyors) could be converted to manufacture a differently designed product altogether if technology or markets warrant a change.

It has been appropriately stated that, "the organization that rushes into this thing blindly is going to lose its shirt, and the one that doesn't go in at all is going to lose its market." The success of each individual management rests primarily on the ability to make an adequate decision at this point. Basically all mechanization must meet the test of economics and each management group must decide for itself.

Recent surveys indicate that at least 16 per cent of production operations in the metalworking field could be automated profitably and a fair share could be done with mere modification of existing equipment. To be specific about various segments of industry, we take the following examples:

In Steel Mills. Automatic centerless grinding is done on a multiple-pass basis in order to prepare automotive spring stock for coiling. This system is automated with conveyor components and standard machine tools to produce an integrated handling system. Fourteen-foot bar stock, ranging from ½-inch to 1¼-inch diameter, is fed either by overhead crane in 6-ton bundles or singly from bar straightening operations through a double-pass grinding operation. Inspection for rough and finish size can be automatic or manual. By expanding on this automatic centerless grinding operation, a coil spring shop has been profitably mechanized. The standard components in the process such as bar straighteners, centerless grinders, bar heating equipment, bar coiling equipment, and standard heat treating furnaces as well as shot peening and paint processing equipment are combined through the use of creative engineering and integrated conveyor systems to produce over 600 automotive coil springs per hour.

In The Forge Shop. Crankshafts are processed from mill-length billets to balanced crankshafts with an integrated conveyor system and standard forging components. The billet is preheated, then sheared to forging length, automatically transferred to any one of three forge lines, loaded into and unloaded from a forge furnace. Single billets are then processed through descalers, reducer rolls, and to one of three 6000-ton presses where the conveyor delivers the billet to die level; then the billet progresses through trim press, upsetter, cam twister, and restrike press. Hot forgings are then delivered through the heat-treating, cooling, and shot blasting cycle by conveyor. The trim press scrap is delivered direct to gondola car by a conveyor from each of three press lines. This too is done with standard components and an integrated conveyor system.

The conclusion emphasized from the examples is that the integration of handling operations into automatic production systems can be most economically realized through the use of standard machine tool equipment and integrated conveyor systems. Such systems must be produced through mutual consultation using managerial imagination and practical creative engineering skill.

Today's trend is toward integration of standard machine tool components and controlled conveyor facilities to produce "work-flows." The relative inflexibility of production facilities resulting from completely automated systems must be carefully measured by management. Obviously, the most economical level of convertible mechanization is the desired objective.

Automation is an idea in the mind of management; the idea must be practical. Integration is the practical application of the idea.

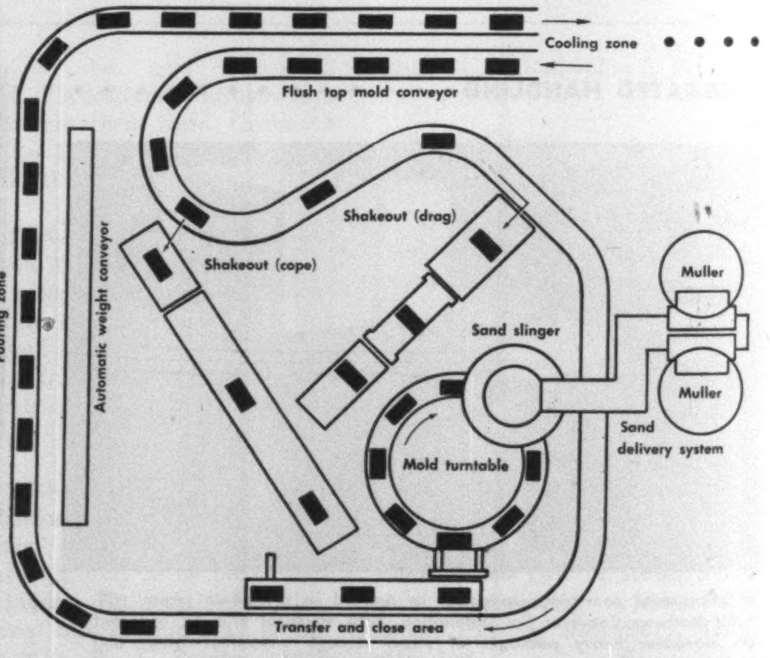
New Handling Equipment Meets Expanded Needs

By W. H. PHILLIPS
Vice Pres. & Gen. Mgr.
Hapman-Dutton Co.

LED BY high-production plants, all industry—large and small—is investing heavily in more fully automatic production and processing equipment. And between each automatic unit lies one of the few present-day opportunities for major cost reduction: the more efficient, automatic handling of bulk materials and parts from operation to operation.

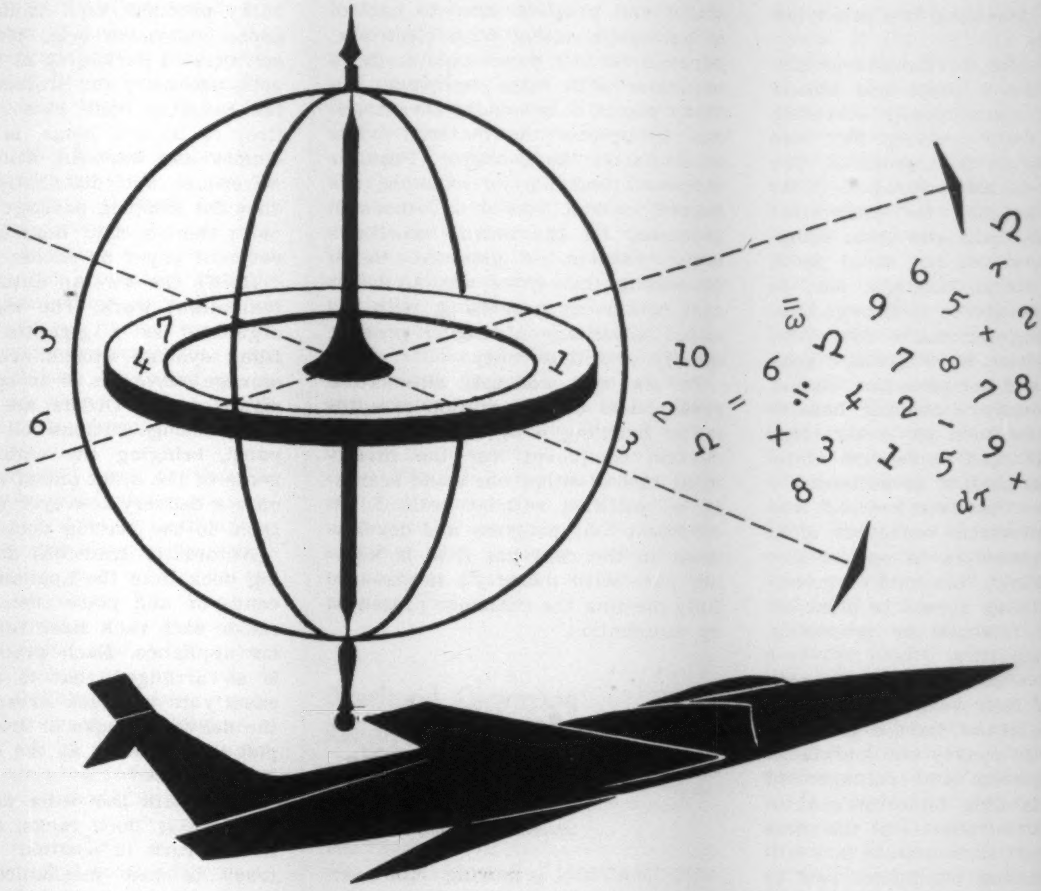
Since materials handling equipment manufacturers are aware of this situation, they are busily improving and expanding their product lines. Our company, for example,

INTEGRATED HANDLING • • • • • •



IN THE FOUNDRY

FOUNDRY indicated in diagram produces automotive cam shafts at rate of 1000 per hour, or 200 molds per hour. Standard machines are combined with integrated conveyor system designed by Service Conveyor Co., Detroit. Shake-out sand, new sand, seacoal, and bentonite are automatically mixed and alternately batched to the sand slinger which rams the flasks. Synchronized weight conveyor automatically positions weights on the mold for the pour and cool cycle.



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Autonetics Engineering Personnel Office, Dept. 991-20AUT,
12214 Lakewood Blvd., Downey, Calif.

Autonetics
A DIVISION OF NORTH AMERICAN AVIATION, INC.

has recently developed two new types of conveyors.

One, the Hi-Lift Cableveyor-Elevator, includes a cable and bucket system for automatically elevating everything from welding flux and foundry sand to food products. The other, a metal belt Pan-Link Conveyor, is designed for integration with machine tools and other equipment for conveying hot metal parts, stampings, spiral turnings, etc., to the next operation or to storage bins.

By utilizing automatic conveyors, many industries have reduced accident rates and compensation claims. By mechanically conveying hazardous materials such as metal chips or chemicals—and unpleasant materials such as sludges or sediments—labor turnover has been reduced. And costwise, automatic conveyors often amortize themselves in one or two years. Certainly, this kind of investment has strong appeal to plant officials with financial or production cost responsibilities.

We who work closely with conveyors, and fully realize their cost-cutting capabilities, have a great responsibility to convey our knowledge to the engineers and management men now planning tomorrow's automated industrial plants. At the same time, we must demonstrate how automatic handling equipment can be integrated with existing plants and machines to relieve today's constant squeeze of higher material and labor costs.

There are so many types of conveyors, and so many application possibilities, it is difficult to describe how automatic controls add to the obvious benefits of mechanized handling. However, it is economically sound and practical now to control a conveyor's action with electronic, punched card or paper tape methods in unison with other equipment. In many plants, it is equally advantageous to process the material while en route on the conveyor. Food or chemical products, for example, are heated, cooked, cooled or otherwise processed on the move, sometimes under vacuum or pressure. Batch processing thus gives way to lower cost continuous processing, with the added advantage of higher product quality and uniformity.

In its very concept, automation presupposes the integration of automatic handling with automatic production equipment, for the investment cost of either one could scarcely be justified without both. I am confident that progress and development in the conveyor field is keeping pace with industry's needs—and fully meeting the challenge presented by automation.

Automation Revolutionizes Warehousing and Distribution

By L. J. BISHOP
Vice President
Mechanical Handling Systems Inc.

AUTOMATION is moving—and moving swiftly—in so many directions that only a partial report on the new trends in integrated handling is possible. Not only is automation spreading in extent and application in manufacturing, but it is also entering new fields, to take over much of the heavy or menial work there.

The first new field I think of is in the warehousing and distribution of bulky products such as home appliances, television sets, phonographs, etc. Present packaging of these products, necessary for protection during the handling from plant to dealer's floor or buyer's home, is expensive, clumsy and wasteful. Automation in warehouse and distribution will reduce the shipping package to nothing more than a skid base and a dust cover of paper or plastic film.

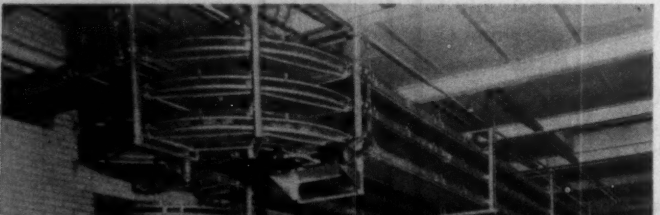
Here's the way an automated system might work. The warehouse is organized as a gigantic automatic filing system. Stocks are either on storage conveyors or in specially designed racks. Orders are assembled by pressing buttons on a control panel, bringing the various components of the order out of storage and onto a delivery conveyor which takes them to the loading dock.

Automatic transfers at the loading dock take the appliances off the conveyor and place them in special racks, each rack sized for a particular appliance. Each group of racks is so arranged that it corresponds exactly to the rack arrangement on the delivery trucks or trailers which pull into position at the edge of the loading dock.

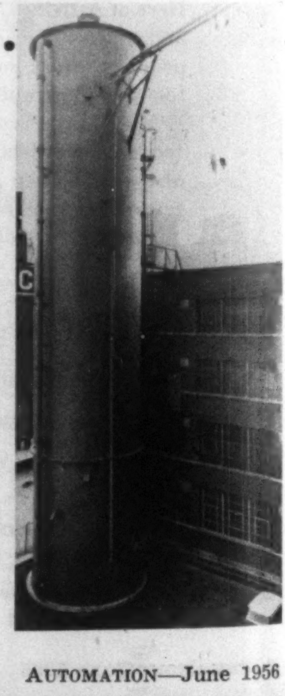
Now, with the order assembled in the loading dock racks, and the delivery truck in position, loading the truck is done mechanically—all at one time and automatically in a matter of seconds. Trucks will be able to deliver direct to dealers in a 200 to 300 mile radius of such an automated warehouse operation. With handling accomplished by gentle mechanical means, present-day protective packaging can be reduced to a minimum.

This "new" idea for automation

INTEGRATED HANDLING •



BAKERY installation illustrates versatility of the steel wire belt type conveyor, specifically designed to convey lightweight products. Installation of this type of equipment is relatively simple and adaptable to existing plant layout. The illustrated cooling-in-process application was engineered by Union Steel Products Co.



OUTDOOR storage silo for raw cornstarch suggests, by its size, the importance of pneumatic conveying to some process industries. Material is filled and reclaimed from the silo by pneumatic lines. Also outdoors, an air material separator located above use bins removes starch from the conveying lines and feeds the bins by gravity means. Fuller Co. engineered this pneumatic conveying system.

has its roots in a system which was working about 25 years ago. At that time we designed and built a device which completely loaded automobile bodies on special trailers in just six seconds.

Another utilization of automation, which is certain to grow, is the assembly of products through transfer machines and conveyors. In this category are the automobile engine plants recently put into operation and the production lines which start with raw stock and turn out finished parts after many successive operations. Automation will also be called on increasingly to carry large, heavy, clumsy products through assembly and processing.

In this category, too, are smaller assembly operations which are surely going to be done by automation with greater and greater frequency. An example of this would be the installation of hinges, for instance, with the assemblies moving from position to position and with operations accomplished as the work is stationary. Drilling, tapping, positioning of hardware and driving of screws can all be completely automatic and accurately indexed to exact positions for automatic assembly operations.

A third interesting development may be expected in commodity warehouses and freight terminals. Automation has made a start here in conveyors which tow wheeled carts from place to place. These tow conveyors are bringing a welcome degree of mechanical organization and automatic handling to these facilities.

At present, tow conveyors are simple loops which require manual labor to attach and remove the trucks for loading and unloading.

In the near future, automatic dispatch systems will be adapted to tow conveyors, and instead of inflexible single tracks, tow conveyors will become systems with switches, storage tracks, marshalling areas. Trucks will be dispatched from one point on the conveyor system to any other—to be switched off the main track at a certain point, held on a storage line or routed back on the main line at will.

To accomplish this automatic dispatch, trucks will be fitted with an inexpensive device—a type of memory system—on which instructions may be preset for the desired movements to be carried out automatically. Work is being carried on with radioactive materials in remote signalling systems which will actuate switches and controls without any connections through wiring or mechanical linkages.

Overhead Conveying Requirements More Complex

By CARL HARRIS
Vice President
American Monorail Co.

MOVEMENT of parts or materials via overhead trolley conveyors and automatically dispatched monorail carriers becomes more complicated with each new application. Only a properly designed integrated handling system can prove profitable in the face of this increasing complexity. Consider an example. Such processes as cleaning, degreasing and finishing can be accomplished on individual continuous loops of overhead conveyors or on monorail track by means of dip sections with gravity return runs. This, however, means loading or manual transfer between each operation due to the different time elements involved.

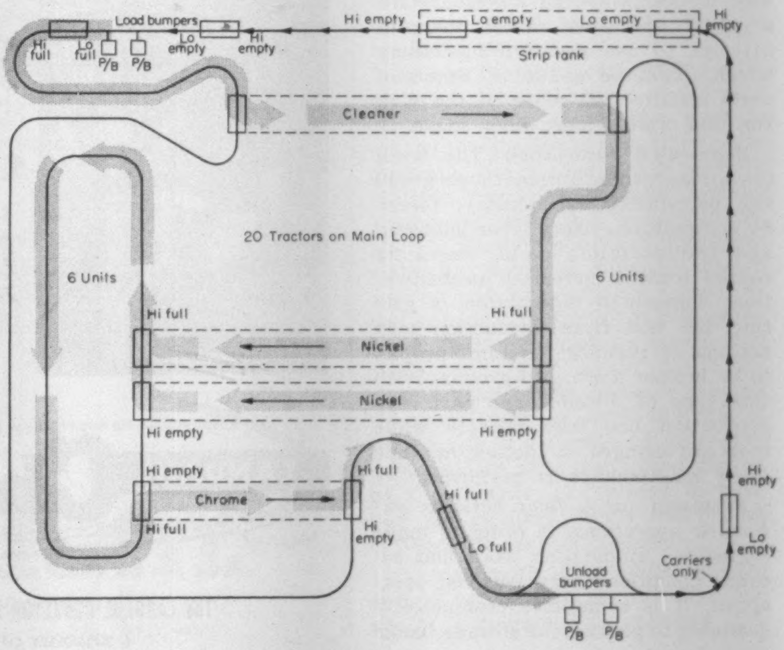
To integrate these processes in a completely automatic plant for plating automobile bumpers, a monorail system, including 32 automatic dispatch units and 14 level changing stations, was designed to operate on three separate loops of monorail track. One main loop enclosed two smaller independent loops.

Beginning empty at the lower level on the main loop, the automatic units are loaded with carriers containing raw bumpers and by pushbutton control are raised to the high level for automatic dispatch to a cleaning tank. Here, the carriers are deposited, automatic units returned to high level and dispatched to the discharge end of the chrome tank.

The unit upon lowering, engages a carrier loaded with finished bumpers, lifts the carrier from the tank and moves to a station for lowering to the unloading station.

After unloading, dispatch units with empty carriers are then raised to the high level for transfer to a stripping tank where chrome deposit is removed and reclaimed from the carriers. Units return to the original low loading level. The main loop consists of 20 automatic dispatch units with eight level change stations as outlined.

At the same time that the above movements are made, the two inside loops, each with six automatic dispatch units and three level change stations, operate to transfer the bumper carriers between the clean-



BUMPER plating installation designed by American Monorail Co. consists of three separate monorail loops. Bumpers move over the indicated path from load to unload point. Balance of system co-ordinates the movement and transfer of carriers between tractor units in cleaning, nickel and chrome plating, and stripping process. The overall arrangement compensates for the variation in processing times between the several processes.

ing tank discharge and the deposit end of the chrome tank.

All the above movements from loading to unloading run automatically. The dispatch units except for pushbuttons at these stations, operate electrically through cascade block circuits. When a unit stops, it stops all following units within the block. And conversely when it starts up, the following units move again in spaced intervals.

This example of an integrated system illustrates an important aspect of modern industrial handling—the transfer of parts between conveyors. Thus it is that integration calls for integration within the handling operations as well as integration of handling with production processes.

Long Run Savings With Special Handling Equipment

By JOHN RUMSEY
Chief Engineer
Jervis B. Webb Co.

THE EXTENT of automation, type of conveyor and transfer devices employed, and the design of material handling system should all be dictated by product, processes required, production volume, production sequences, machine employed and cost of methods considered. With such an array of design considerations generalizations are difficult; however, certain trends in materials handling can be identified:

Design of the part with automation in mind. Where possible, engineers are changing the part design to permit a higher degree of automation.

Special versus standard machinery. The trend indicates that it is preferable to design special machinery for a given operation rather than to attempt to use standard machinery which might be available. Standard units usually cost more in the long run and occupy more floor space.

Segmented automation. The trend toward segmented automation is growing perceptibly as industry, forced by competition, rising labor, material and transportation costs, steers its course toward increased mechanization. Segmented automation is getting the nod from production men because it permits the total project to be broken down into groups. With this type of division, one part of a production line may operate while tools are changed on another, or while other maintenance is performed.

Provision for a float between automatic operations. In order to make segmented automation work and because conditions vary between operations, it is sometimes economically desirable to provide for storage banks

Landahl Conveyor removes bags from 24 mailing tables.

Empty bags mounted on special carriers are hung on top notch of conveyor arm.

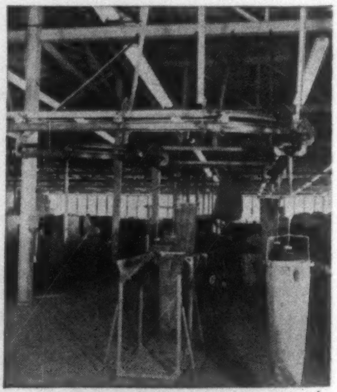
LANDAHL CHAINLESS CONVEYORS

Save 24 man hours daily

The mail department of this large plant has Landahl Chainless Conveyors paying for themselves every six months, for the overhead system saves 24 man hours per day.

Landahl Engineered frames hold empty mail bags on the top notch of bag carriers and are lowered for automatic pick-up as they are filled at 24 different mailing tables. From the tables the bags roll to the unloading bin where full ones are kicked off the frames. Empty ones go right back to the tables.

Operator places loaded carrier in position for pick-up by lower notch of carrier arm.



Loaded carriers are automatically released from conveyor to roll on rack to unloading point.

LANDAHL Chainless CONVEYORS

The LANDAHL CONVEYOR CO., 13144 Athens Ave., CLEVELAND 7, OHIO
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between operations. For example, in a glass plant the glass furnaces work 24 hours a day, while the batch mixing department can keep up with furnace production in an 8-hour shift.

Automatic assembly. More companies are giving additional thought to the benefits to be obtained with automatic assembly. A recent example of this trend is the automatic assembly line for Plymouth's new V-8 engine in which various studs, nuts and bolts are tightened automatically.

Automation Answer to Rising Handling Costs

By R. W. ROBERTS
Asst. Sales Manager
Whiting Trambeam

and

By R. F. RICE
Manager
Whiting Crane Dept.

Whiting Corp.

BECAUSE of the high cost of material handling—about 25 per cent of the cost of a manufactured product today is in moving it from place to place—we at Whiting have noticed a definite increase in customer interest in automation. At the same time, we cannot honestly say that we have noticed a wholesale swing toward this method of operation.

The reason that this trend has not been more pronounced probably rests with the fact that the full potentialities of automation are not yet understood by prospective users, and because the equipment manufacturers have not capitalized to the fullest extent upon the qualities in their equipment which would make it suitable for automatic operation. Not to be overlooked, too, is the fact that many of today's "automatic" plants represent industry firsts, and an initial installation of any kind, because of the necessarily large amount of time and effort expended on it, is unusually expensive.

In one foundry, completely automatic cupola charging has been achieved. Here, the bucket used to charge the cupolas is first filled automatically and is then picked up by a Whiting Trambeam charging system. Trambeam raises the bucket to the high or charging point and then automatically moves it forward toward one of the two cupolas served by the system. The bucket moves slowly at first, increases its speed, and then slows down again as it approaches the cupola. When it reaches the proper position inside the cupola, the bucket is lowered and automatically emptied. It is then raised, moved back and down, and placed in position for refilling. When the bucket is filled, the cycle is repeated.

Coupled with this operation are several safety devices, including one which automatically prevents the

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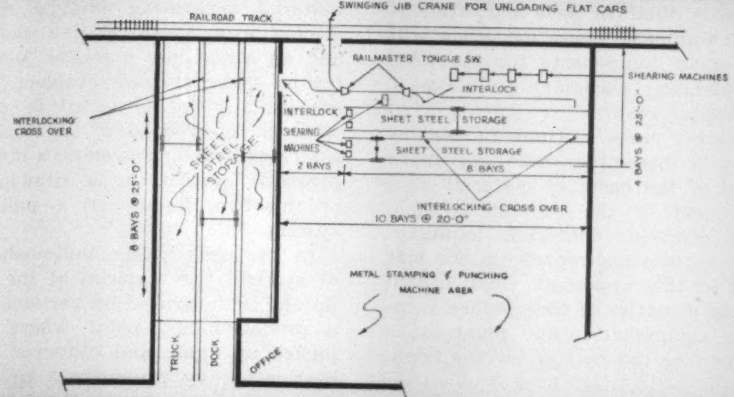
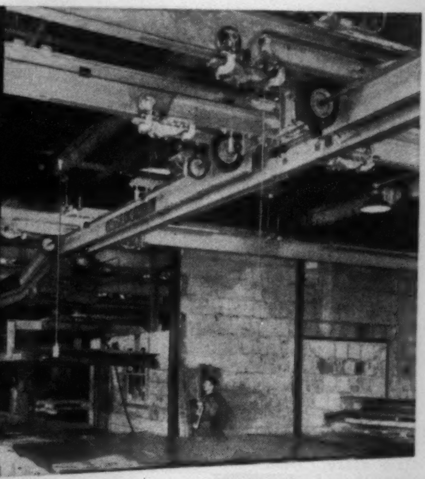

SWINGING JIB CRANE FOR UNLOADING FLAT CARS
RAILROAD TRACK
RAILMASTER TONGUE SW.
INTERLOCK
SHEARING MACHINES
INTERLOCKING CROSS OVER
INTERLOCK
SHEARING MACHINES
SHEET STEEL STORAGE
SHEET STEEL STORAGE
SHEET STEEL STORAGE
2 BAYS
8 BAYS
4 BAYS @ 25'-0"
8 BAYS @ 25'-0"
INTERLOCKING CROSS OVER
10 BAYS @ 20'-0"
METAL STAMPING & PUNCHING MACHINE AREA
TRUCK
DOCK
OFFICE



handles
200 tons
more steel per day
with
AMERICAN MONORAIL

The Hamilton Steel Products Company of Chicago now handles 250 tons of sheet steel per day with American MonoRail cranes as compared to 50 tons by previous methods. An increase of 400%.

This is just another example of cost savings with improved handling methods which are regularly realized by American MonoRail users. If you have a materials handling problem call your American MonoRail representative or write us today.

Send for Bulletin SC-1.

Member of Materials Handling Institute and MonoRail Association

AMERICAN
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bucket from emptying its load unless there is sufficient space for the charge in the cupola. Not only does this equipment greatly reduce the number of men needed in this segment of the plant, but it practically eliminates human error. In a short time, this alone more than pays for the increased cost of the special equipment.

The interest in automatic operation has extended also to heavy industrial cranes, and Whiting has installed a number of these units with marked success. One such installation, a large chemical plant, required cranes for work in an area from which all workmen had to be excluded. It was necessary for the cranes to travel to any one of a number of points in a building to perform any or all of several operations—locate the hoist over a specific point, lower a grapple and make contact with the load to be lifted, pick up the load, deliver the load to another point, and return to the starting point. Extreme accuracy, too, had to be achieved in these operations. The grapple, for example, had to be positioned over the load with a tolerance of about 0.01-inch.

We at Whiting feel that the future of automation is bright. Certainly the potential is there. But before it can take its rightful place in the American industrial scene, considerable groundwork must first be laid.

Of prime importance is education. The potential users of automatic equipment must first be made fully aware that such a thing as automation exists. They must then be shown its advantages and how it can fit into their own plants profitably. They must see examples of how automatic facilities are being utilized in plants similar to their own.

In actually planning for automation, production people must first decide what they hope to accomplish with automatic equipment. What do they want the equipment to do? This should be worked out in detail.

The advantages and disadvantages of automatic operation must be carefully weighed against one another, and the equipment itself must be carefully selected. If economically justified and if automation can be indeed accomplished in the specific installation, then the ease and efficiency of automatic operation alone will more than compensate for the time and planning necessary to make it a practical reality.

As labor costs continue to rise, industry is becoming more and more aware of the costs of material handling—and of the savings possible with efficient material handling. Since automation represents the last word in this important field, it will be only a matter of time before automatic equipment in the plant is as common as the tractor on the farm.

Versatility Expands Pneumatic Conveying

By R. R. HEARD JR.
Sales Engineer
Fuller Co.

PNEUMATIC conveying means simply what the words indicate—conveying by air. This vital new production tool is now rapidly being integrated into most fields of industry. The handling of minerals, plastics, paper, chemicals and foods is now implemented by pneumatic conveying. Not only is it versatile in the types of industry it serves, but it is also versatile as to the work done per time unit; the range of quantities moved varies between a few pounds per minute to as much as 10,000 pounds per minute.

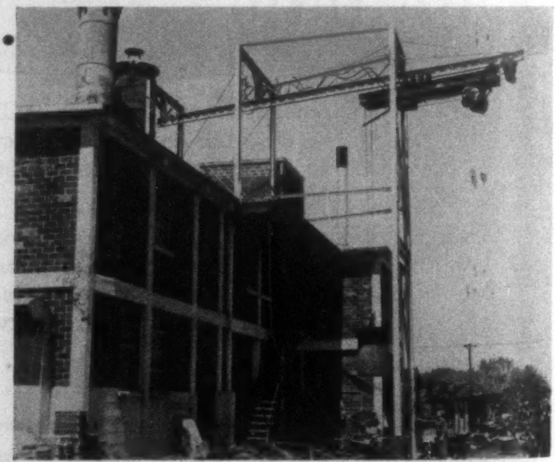
The physical make-up of the Airveyor system, as it is called by Fuller Co., may vary considerably with each application, depending upon the exact nature and extent of each problem. However, from an equipment standpoint an Airveyor basically consists of a conveying duct, an air-material separating unit, a rotary discharge lock, or a line charger, and an air supply machine. Depending on the conveying problem, these essentials may be varied to create what is referred to in the trade as a straight vacuum system, a straight pressure system, or a combination of the two, known as a pull-push system.

In the case of the pull-push type of system, the material at the pick-up end is motivated by vacuum up to a predetermined point where it is picked up again and conveyed to its destination by pressurized air. With this dual system, both the inlet and the outlet of the air supply machine are employed.

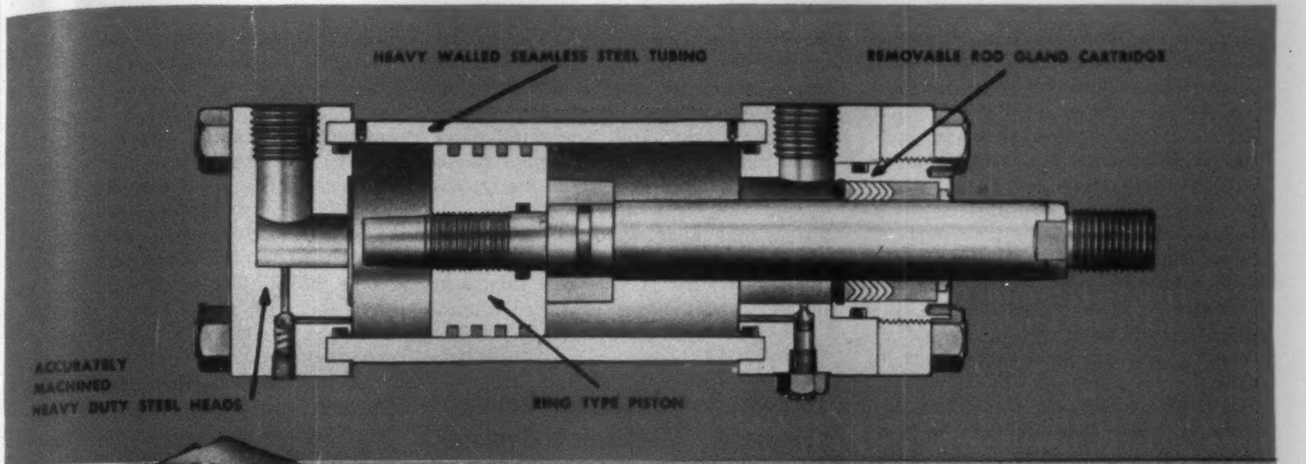
It is important to note that the air conveying is not limited only to the unloading of bulk cars. Distribution of material from various use points throughout the plant or mill to other use points is a problem easily solved. Here we may find that material will have to be delivered to a daily use bin, or to holding hoppers over one or more pulverizers. Ordinarily, we might assume that, with several de-

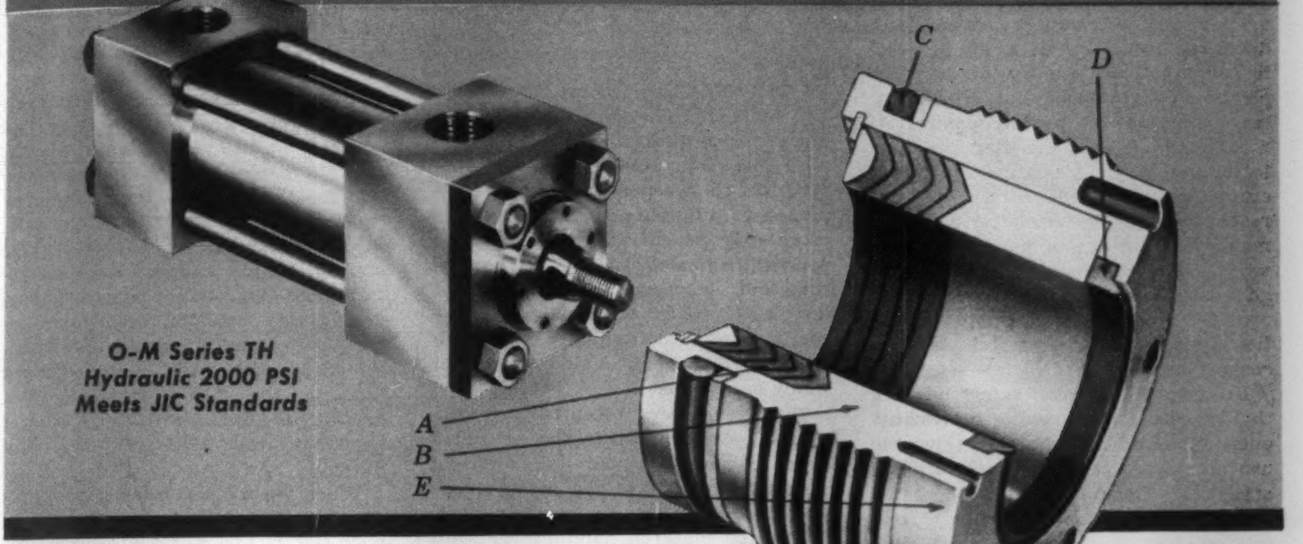
INTEGRATED HANDLING • • • • • • • • • • • • • •

AERIAL view of generating station with coal handling equipment jointly engineered by Stephens-Adamson Mfg. Co., Gilbert Associates, and New York State Electric & Gas Co. Reclaiming section operates continuously on automatic basis. Entire coal handling system requires services of only three men for continuous operations.



SYSTEM for charging a cupola is type of handling operation which can be integrated into existing equipment setup. By pushbutton control, bucket is automatically raised from the filling level, moved into position and dumped. More than one cupola can be charged from the same system. Safety devices prevent the bucket from emptying its load if a cupola has insufficient space to receive the charge. System engineered by Whiting Corp.


HEAVY WALLED SEAMLESS STEEL TUBING
REMOVABLE ROD GLAND CARTRIDGE
ACCURATELY MACHINED HEAVY DUTY STEEL HEADS
RING TYPE PISTON



O-M Series TH
Hydraulic 2000 PSI
Meets JIC Standards

New O-M High Pressure Hydraulic Cylinder equipped with Removable Rod Gland Cartridge

The O-M-engineered removable Rod Gland Cartridge, exclusive with the O-M Series TH Hydraulic Cylinders, incorporates all the features essential to peak performance and minimum maintenance. It is constructed with a heavy wall steel shell threaded for quick, easy removal, and accurately piloted in rod head to assure perfect alignment. In most applications cartridge can be removed easily without removing mounts or the rod nuts. You simply loosen and remove with a spanner wrench.

A **Rod Packing**—Vee type, non-adjustable, self-compensating, rod gland packing provides multiple lip seal with excellent pressure sensitivity and long life.

B **Rod Bearing**—Extra long, bronze rod bearing provides large bearing surface located well forward for maximum support of piston rod.

C **Cartridge "O" Ring Seal**—With leather back-up washer provides positive seal and acts as friction lock to retain cartridge.

D **Rod Wiper**—Homogeneous lip type located well forward to prevent accumulation of dirt in pocket. Metallic scraper (AN approved) available and interchangeable with wiper.

E **Pilot**—O.D. of cartridge serves as pilot for cylinders mounted on rod end.

O-M Series TH High Pressure Hydraulic (oil) Cylinders—conservatively rated at 2000 P.S.I.—are available in bore sizes 1½ to 8-inch inclusive. Descriptive drawings of cylinder, mounts, mounting brackets and capacity chart are included in the new O-M Bulletin 105. Mail coupon for your FREE copy today.

ENGINEERING SERVICE—consult an Ortman-Miller representative regarding your hydraulic or pneumatic problems. His broad experience with standard and special cylinder applications is available to you without obligation. Use convenient coupon.

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livery points at remote locations in the plant, several conveying systems would be required. This assumption is incorrect, because it is possible to serve 20 to 30 delivery points with only a single system. Such a system would provide for the utmost in simplicity of layout and installation. All that would be required between the various points for transporting the material would be a relatively small-diameter pipe which provides for extreme ease of installation, inasmuch as it is a simple matter to string a run of pipe throughout a plant.

Control components contribute immensely to the flexibility of the Airveyor in that they permit ease of diverting the conveying stream into different directions so as to be able to serve a large number of delivery points, or to pick up material at a large number of feed-in points. A decade ago it was accepted practice to employ nothing but manually operated switching elements. However, recent years have seen the development of a full line of automatic conveying line switches, diverting gates and turn heads which collectively provide for complete remote operation of the conveying system from a central control panel.

In summation it can safely be said that pneumatic conveying has many outstanding advantages, among which are simplicity of layout, ease of installation, flexibility of application, low handling cost, cleanliness of operation, low maintenance costs, and the utmost in sanitation. These advantages can be weighed on a competitive basis in the case of handling any material, either organic or inorganic. However, in the case of a modern food plant they can rightfully be amplified many fold, due to the cleanliness and sanitation factors, which minimize the possibilities of contamination and infestation. Therefore considering that more and more food plants are converting to pneumatic handling, it is naturally assumed that they have duly investigated and acknowledged the many advantages that pneumatic conveying has to offer. Its biggest future in industry in general still lies ahead.

Cost-Minded Engineers Desire Completely Mechanical System

By HOMER S. HARRISON
Chief Design Engineer
Allied Steel & Conveyors Inc.

IN THE FACE of rising labor costs and increasing competition, both domestic and foreign, managers who wish their companies not only to survive but to prosper are firmly committed to automate as promptly and completely as current resources and present technology permit. Plant automation, however, without planned integrated material handling is not really automation at all, any more than a body without a skeleton would really be a man.

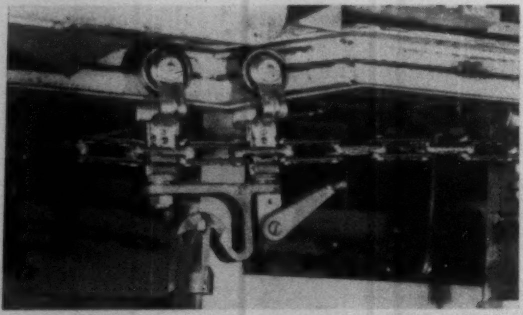
Plant engineers recently have expressed strong desires for an overhead conveyor system—since it is generally considered the most versatile and efficient—to provide truly integrated material handling, i.e., the sine qua non of automation.

This desire is not surprising considering that a large percentage of total production cost is represented by material handling operations. Ideally, what they are after is a conveyor system which would include automatic dispatching, loading and unloading at any desired number of stations along a line. It should also provide automatic timing and transfer to follow the pace of processing equipment, afford circulating storage when required, and maintain positive load control even through transfer points. And, of course, it must be simple, economical and able to handle all parts formerly handled manually—all in a single type of conveyor.

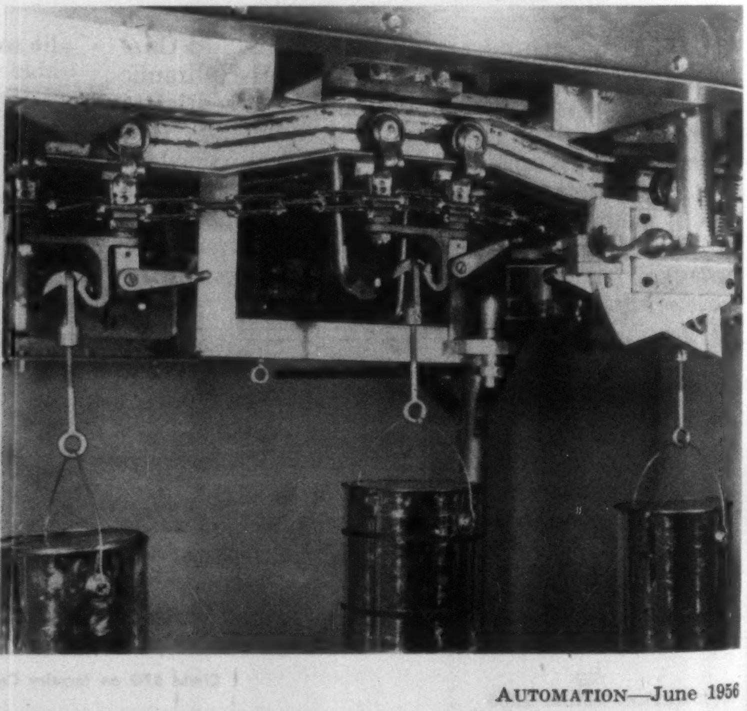
A big order? Certainly. But visualize if you will its benefits. Here is a plant manufacturing units of a type that lend themselves to overhead handling. Rough stock for various parts is loaded at the receiving department and dispatched for processing. As loaded carriers leave any station they are automatically dispatched to the next desired station. Many different kinds of parts can be handled on the same line at the same time, each being routed automatically to the proper processing or storage station. Empty carriers are then returned to the loading area. Painting, drying and washing operations, incidentally, may be done at individual stations with all parts passing through the same stations. This, briefly, is the pleasant picture of properly integrated material handling.

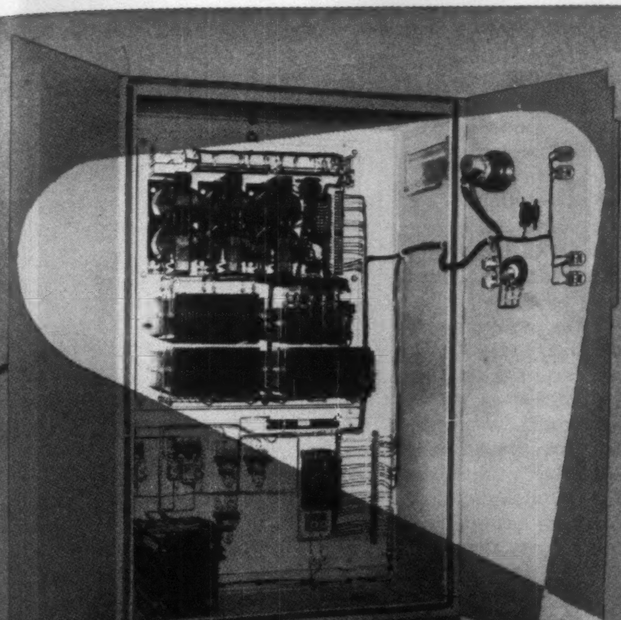
When we set out some time ago to design a conveyor system consistent with the requirements of automation, we were determined to come up with a completely mechanical system which could utilize existing standard manual equipment to keep both installation and maintenance costs at

INTEGRATED HANDLING • • • • • • • •



COMPLETELY mechanical system of load transfer between main conveyor lines and free or auxiliary lines has been developed by Allied Steel & Conveyors Inc. Details at typical transfer point are pictured. Load is traveling from right to left, and in accordance with preset conditions has triggered movement of transfer hook bringing it into position to engage load. Transfer hook on free conveyor is traveling at same speed as main conveyor.

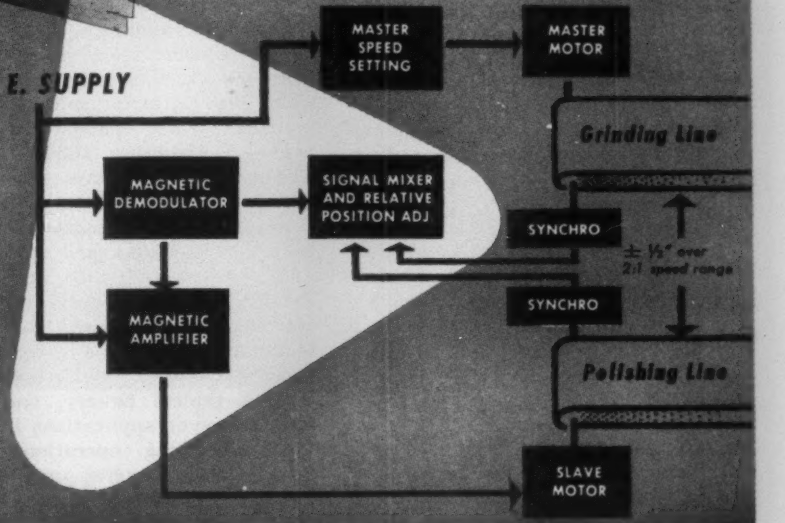




Magnetic amplifier controlled synchronizer unit installed at Mississippi Glass Company, St. Louis, by Hornbeck and Hardie Electric Company, St. Louis.

PRECISION SYNCHRONIZATION FOR CONVEYOR

with a VICKERS magnetic amplifier control system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SYNCHRO
± ½" over 2:1 speed range
SYNCHRO
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SLAVE MOTOR

IN THE MANUFACTURE *of Polished Wired Glass, a series of grinding and polishing operations employing increasingly finer grades of abrasives and a polishing agent is necessary to achieve a smooth, flawless surface. In this particular case, grinding and polishing is accomplished on two separate but parallel conveyor lines.*

Since it is necessary that the tables which carry the glass be transferred from one line to the other, and since other machinery must be coordinated with these lines, it is necessary that the relative position of the two lines be synchronized with each other at all times.

A visual method of synchronization which involved a stop-watch and ruler proved unsatisfactory.

The problem is solved by the installation of a Vickers Magnetic Amplifier Controlled Synchronizer. This synchronizer controls the speed of the polishing "slave" line. The speed signal is derived from synchros which detect relative conveyor position. By this technique, the positional accuracy between the two conveyor lines is held to less than ±½ inch throughout a 2:1 speed range for the grinding "master" line.

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an absolute minimum. How well we succeeded with our new system—which is called Trans-Free—may be measured by the fact that although it is completely mechanical in all of its operations, it nevertheless has fewer mechanical parts than a comparable electrical system requires in its mechanical phases alone! It is built of standard overhead I-beam track, uses regulation load carriers, dispatches materials manually or automatically from any point in the system to any other, provides processing and storage loops at any desired location on either side of the transportation conveyor and features positive load control at all times.

With this system the manufacturer without the capital to automate his entire conveyor setup at one time can now do so gradually while continuing to use his present equipment in conjunction with Trans-Free sections. Bringing an automatic, trouble-free conveyor system within the financial reach of more and more manufacturers not only makes it possible for many individual businesses to remain competitive but even more importantly helps hasten that day when each of us may enjoy the full benefits of automation.

Light Product Conveyor Gains In Food Industries

By C. W. STEINHAUER
Vice President
Union Steel Products Co.

TODAY the modern, light product conveyor is probably the most outstanding and most rapidly developing piece of equipment in the food industry. Though its introduction has been relatively recent, the powered steel wire belt type conveyor has already built up performance records to substantiate the value of integrated handling in this industry. A typical modern bakery installation provides an excellent example.

Five short years ago, the ultimate conveyor objective, both on the part of the manufacturer and the bakery operator alike, was to diminish bread handling between the wrapping machine and the delivery truck. This would eliminate wrapper damage, cut down on storage space and, if possible, get route trucks on the road faster. Conveyors proved their worth in this use so conclusively that bakers soon demanded the introduction of conveyor economies in other important process operations throughout their plants. It is now apparent that the majority of the nation's bakers are interested in the elimination of all product handling.

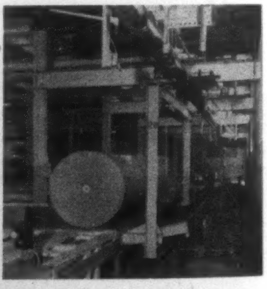
The modern, steel wire belt type conveyor which operates over smooth, nylon bearing strips mounted on galvanized, formed channels is an ideal conveyor to bring about this end. These units can travel anywhere in the average shop, turn corners, go through walls in single or multiple tiers and sections are self-powered and synchronized with desired production speeds. In short, this type of conveyor can be adapted to machine locations rather than machine locations to conveyor requirements.

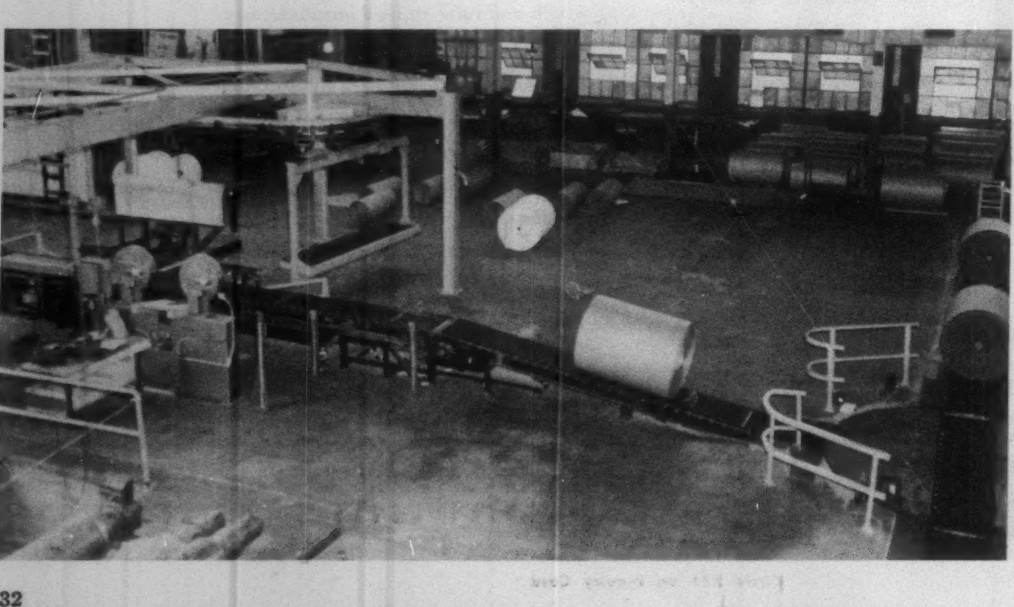
In a typical bakery, one of the first conveyor applications in the actual processing operations is the dough piece transfer unit conveyor located between the automatic overhead proofer and the molder-panner. Here the linked, steel wire rod conveyor belt has a very distinct advantage. The sanitary belting conveys the raw dough pieces without stickage, abundant dusty flour, and man handling.

Another practical application of conveyors in the processing of bakery goods occurs at the oven. Here, oven-hot products such as rolls, cluster buns and bread, may be dumped directly above the conveyor chain or belting at a convenient working height. The products are then smoothly, quickly and silently moved to ceiling level or any desired location for a delayed travel and cooling period. This use of the conveyor as a part of a cooling system is one of the most significant applications in the industry today.

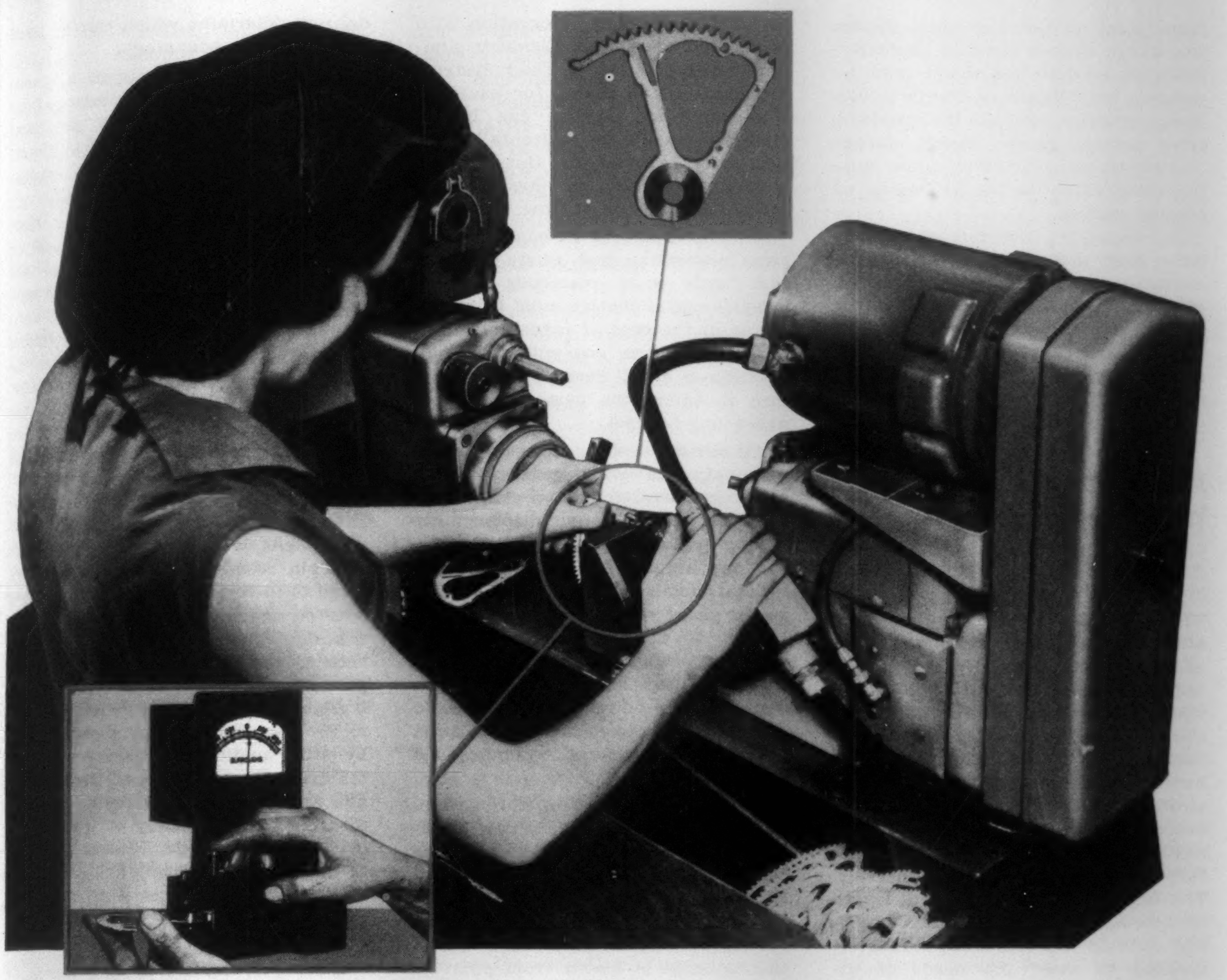
Modern baking plants include an application that is more complicated than these previously mentioned. They are equipped with a conveyor known as the automatic tier selector which is a remote controlled unit that practically thinks for itself. For example, freshly cooled loaves of bread from the automatic cooler are received by the conveyor, usually at ceiling level, and are conveyed toward the selector unit which automatically times, spaces and distributes the fresh loaves to a battery of slicer-wrappers. Conveying from the slicer-wrapper to the loading area or route truck follows practices which have long been standard in the industry.

The use of the conveyor is not limited to the sturdier type of bakery product. More and more bakers are turning to modern conveyors as a means of transporting pies, cakes and other light, unwrapped products





INTEGRATED system installed in Camp Mfg. Co. plant by Lamson Corp. involves belt and overhead conveyors. As they are received from paper machines, heavy rolls are weighed on special conveyor scales, automatically transferred to cars of overhead conveyor and directed to one of nine unloading stations. Operator at control panel near scale selects the desired unload point. Unloading is accomplished automatically when car reaches the proper station.



"HARTFORD" Air Hydraulic Drill Units used by Burroughs* to hold precision thickness tolerance

SPOTFACING BOTH SIDES OF A WAFER THIN STEEL GEAR SECTOR TO A THICKNESS TOLERANCE WITHIN .0003" IS ONLY ONE OF THE ADVANTAGES BURROUGHS OBTAINS BY USING HARTFORD DRILL UNITS.

Add up these facts:

1. SPINDLE ACCURACY of units holds parallelism of machined faces.
2. MICROMETER DEPTH CONTROL of Drill Units provides *positive* stop.
3. PRODUCTION DOUBLED over previous method of facing one side at a time. Machining cost cut in half.
4. EXTREME LOW COST of special machine through use of *standard* Hartford components.
5. REJECTS ELIMINATED because the accuracy is *built into the machine.*

*Internationally famous makers of Sensimatic accounting machines.

Another example of better products at lower cost through better methods.

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from point to point in their plants. The clean, smooth running characteristics of modern conveyors hold no dangers for delicate or fragile goods. They actually protect the products from careless hands, unsafe storage and rough transportation, while moving them safely to the packaging or boxing station.

In summary, conveyorized plants have long since passed the experimental stage. They are the practical, efficient, time, product, and labor savers that help retain an outstanding appearance of the food product and the annual statement simultaneously.

Any Degree of Automation With Pneumatic Conveyors

By D. E. PERKINS
Asst. Chief Engineer
Dracco Corp.

THE LONG-RANGE trend toward automatic, continuous flow production in the process industries is demanding ever closer integration of material handling systems. For the movement of dry, bulk materials, pneumatic conveyors with their many inherent advantages are the logical answer. They are readily adaptable to automatic control and provide a swift, smooth flow of materials to, through or from production processes. The capacity, complexity and degree of automation of pneumatic conveying systems are constantly being increased to meet the needs of industry.

In pneumatic conveyors, the airborne materials exhibit many of the flow characteristics of moving fluids, permitting complete integration with production operations. Elements similar to those found in fluid systems are used—surge tanks, for example. The conveying pipeline can be installed vertically or horizontally, under, over, around or through obstacles. There are no physical limitations in direction of flow.

All movement is in enclosed systems, preventing dust, waste and contact with toxic materials. Where product contamination must be avoided, as in the case of foods and high-purity chemicals, conveying air may be filtered of all foreign matter before it enters the system, or inert gases may be used.

All devices used in connection with pneumatic conveying systems can be remotely operated from a centralized control point: Positive displacement pumps which move the air in the system; rotary or gate discharge locks which feed materials; and diverter gates which permit remote selection of two or more conveying paths. In addition to controls for these devices, the control panel can include lights activated by automatic bin-level indicators and switches on the various items of equipment to show flow paths.

Almost any degree of automation, including programming, is now available for pneumatic conveyors. Three types of pneumatic conveyors are commonly used: Vacuum, in which the material is drawn through the system by suction; pressure, in which the material is blown from point to point; and a combination of the two. Engineering considerations such as general layout, distances covered, functions, type of material and speed desired, determine which can be used with greater advantage.

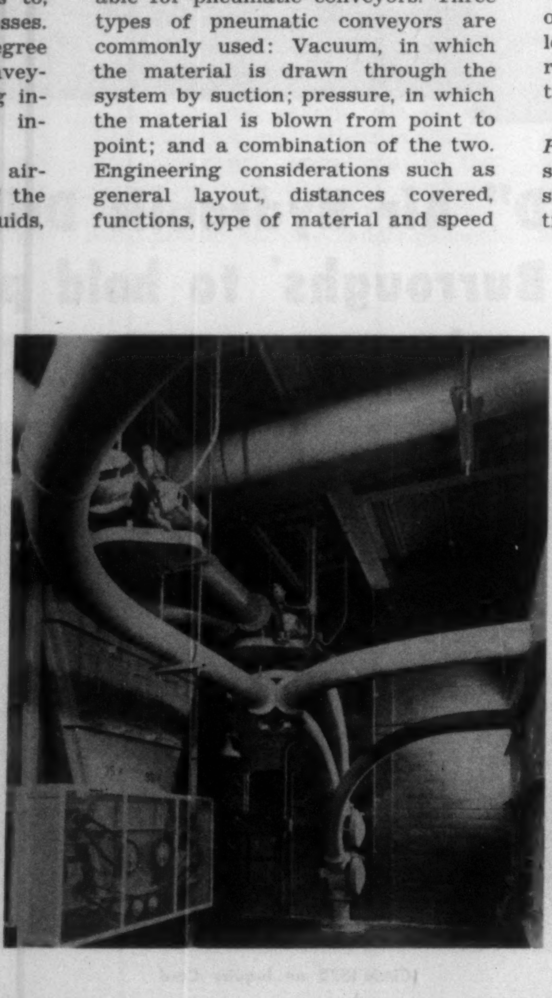
The basic components of a pneumatic conveyor can be adapted to perform any one of four principal bulk materials handling functions:

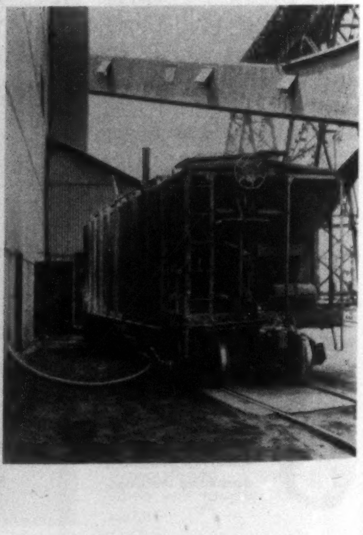
Unloading Materials from Transport to Storage. The operator unloads a rail car or truck by first attaching a hopper to the bottom of the vehicle. He then sets the air stream in motion by pushing a button. Material is drawn into the conveying line and moved to a cyclone type receiver-filter and thence to storage bins or, if needed in process, special provisions can be made for direct movement to process. Where more than one storage bin is being filled, a pressure pneumatic conveying system with a series of diverter gates may be used. Bin level indicators can warn the operator when one bin is almost full, giving him time to divert materials to another bin, or indicators may be used to actually control the function of diverting materials to other bins or processes.

Removing Materials from Storage to Process. This may be accomplished by either suction or pressure systems. Materials are discharged from storage and enter the conveying line by means of either rotary or gate locks or an intake hopper. Since the rate of material flow through a discharge lock is known, the amount of material moved to process can be controlled volumetrically.

Moving Materials from Process to Process. This is done in much the same manner as movement from storage to process. Certain production processes can be accomplished

INTEGRATED HANDLING





PNEUMATIC Conveying system installed by Dracco Corp. for large bakery handles in-plant movement of both flour and sugar. Automatically controlled diverter gates are used to direct materials into various process bins. Material received in bulk loaded cars is unloaded automatically by pneumatic means.

while the material is in transit: Weighing; batching; mixing, by introducing two or more materials into the same line in predetermined proportions; and blending of materials in one or more bins through recirculation. Greater uniformity results from the automatic blending of products. Exclusion of foreign matter from the enclosed conveying lines protects the purity of materials in the system.

Moving Materials from Process to Packaging or Bulk-Loading. As the final step in production, materials are conveyed from process to a packaging machine or directly into transport for bulk shipment. In the latter case, a dust control system is usually added to prevent waste and dusty conditions in and around the loading area. Material collected as dust is normally returned to the conveying line for reloading.

Each of these functions has an infinite number of variations designed to suit individual production requirements. Often, an integrated pneumatic conveyor forms the backbone around which the rest of the plant is designed for maximum efficiency. With the cost of labor increasing annually, the economy of an automatic bulk handling system is apparent. In addition, many users report that their handling costs have been reduced through buying material in bulk, less material waste, cleaner plants and less frequent maintenance and closer control of their processes.

When planning for automatic production using dry bulk materials, a pneumatic conveyor should be considered as a vital means of moving materials because of its flexibility and the variety of handling functions which it can perform.

New Concept Increases Coal Handling Efficiency

By D. W. PARKIN
Chief Engineer
Stephens-Adamson Mfg. Co.

OVER the past ten years amazing advances have been made in the efficiency of individual turbine generators, steam generators and associated auxiliaries. Primarily this has been the result of fundamental design changes, but more and better automatic controls and remote manual control designs have played an important factor. However, coal handling facilities have still ranged from $5.00 to $20.00 per installed kilowatt and average approximately 7 per cent of total power plant cost. In an effort to lower initial costs and operating expense in this area Stephens-Adamson Mfg. Co., Gilbert Associates Inc., and the New York State Electric & Gas Corp. pooled their engineering talents to come up with a new coal handling concept for the latter company's Milliken Generating Station at Cayuga Lake, N. Y.

Heart of the new concept is the use of live outdoor storage coupled with reduced in-plant bunker capacity. A 113-foot boom conveyor discharges coal to a height of 70 feet above four reclaiming hoppers with an open area of 33 by 33 feet. Based on the reclaiming flow angle, there will be readily available for automatic reclamation some 5100 tons. With bunker capacity set at 700 tons this means that there will be 5800 tons of coal available, which is sufficient for 116 hours of operation at a burning rate of 50 tons per hour. Should it become necessary to reclaim coal from the nonactive storage area it will only be necessary to hire a single bulldozer and operator on a one shift per day basis.

Considerable study was given to bunker capacity with actual capacity finally being set by extending the roof above the bunker at the same level as the turbine room roof. Length and width was determined by the space requirements of the pulverizing equipment. Bin indicators above each of four pulverizers will cover a depth range of several feet with remote indications on a panel board in the control room.

The reclaim structure consists of four individual hoppers. While freezing will probably not be a problem due to the almost continuous movement of the coal, steam coils have been imbedded in the concrete hopper. Each hopper is equipped with a combination control and cut-off gate through which coal discharges to vibrating feeders. In combination with the gates and rheostat controlled vibrating feeders, rate of discharge can be controlled from zero to 300 tons per hour.

Coal falls from the feeders to either of two crushers which in turn feed a pair of belt conveyors running to the plant. Each 30-inch belt has a maximum capacity of 300 tons per hour and is provided with a continuous weighing device which is arranged to maintain a preselected total flow of coal from the four feeders regardless of the rate of flow through any one feeder. This metered flow can be set by the operation in the control room.

Since present plans indicate that the reclaiming section of the coal conveying system will be in operation on an almost continuous basis it is expected to operate automatically since there are no gates, trippers or shuttles involved. Thus, the only manpower required in this section will be for the usual maintenance operations connected with this type of equipment. The stocking out section of the system has a capacity of 900 tons per hour and will be required to operate less than ten hours per week on an average to handle the necessary tonnage of coal. With this in mind it is expected that a three man crew will be able to operate the entire coal handling system without a relief man except as required for vacation or illness.

Competitive Economy Demands Efficient Handling Systems

By O. H. McCLEARY
Vice Pres. & Gen. Mgr.
Mathews Conveyer Co.

PRODUCTION people are certainly becoming increasingly conscious of the importance of modern processing and handling machinery which, applied together, result in an uninterrupted flow of material through manufacturing and shipping. There is, of course, greater emphasis than ever before on fully automatic machinery, especially in the larger plants. However, much of our work today is actually very little different than it has been for the past several years.

The word automation is reasonably new, but the things which it brings about are not new, at least to a large extent. The conveyor people have been talking about the continuous flow principle of handling materials for many years. Our company used this as a theme for a rather concentrated program of advertising during the years 1936 to 1940. It would seem that the word automation has been so carelessly used that it now has come to mean many things to many people. For example, we have recently seen the word used in connection with advertising of simple sections of standardized wheel conveyor.

We do not sight this example critically, but it is an indication of the fact that everyone wants to be a part of this trend toward the spectacular. It is true that some of the conveyor companies are really quite far advanced in the development of conveying machinery of a highly special nature, and are doing specific jobs which are unusual and complex. Certainly today's competitive economy demands that every manufacturer keep his eye on automation or whatever he chooses to call it, and that he do every job as efficiently as he can. He should use automatic equipment wherever it is practical and should keep material flowing so that rehandling and lost motion are reduced to an absolute minimum.

Probably automation in the exact sense of the word is a long way off for most of us. However, its influence is with us, and has made us increasingly aware of the vital importance of good production management.

Integrated Conveyors Simplify Complicated Plant Layout

By W. C. COKER
Plant Engineer
Camp Mfg. Co.

PERHAPS one way of pointing out the need for integrating handling operations into production systems is to outline the benefits realized from a successful application.

A complicated plant layout of the Kraft Paper Div. of the Camp Mfg. Co. resulted in high material handling costs. The manufacturing building runs north and south; the warehouse, east and west; production flow ends at a point farthest from the warehouse. Handling costs at this plant have been reduced substantially by the installation of a system of automatic belt, live roll and overhead trolley conveyors, operated by one man. The integrated system of conveyors was engineered and manufactured by the Lamson Corp., Syracuse, N. Y.

Rolls of paper, 50 inches in diameter and from 12 to 72 inches wide, and weighing from less than 100 lb to as much as 7000 lb, come from two slitting machines located on the second floor of the manufacturing building. The system begins at the winders of these two parallel slitting machines. A conveyor from each machine takes the rolls of paper to the same turntable, which, by means of photoelectric cells and limit switches, automatically indexes and transfers the roll to an inclined belt which moves it to a weigh scale. The scale operator weighs the roll, records the weight, starts the conveyor on the scales, and moves the roll onto a transfer unit which, at this point, is parallel to the overhead trolley conveyor.

The transfer unit provides the lateral movement between the two. This transfer unit is capable of handling more than one roll, if rolls are of narrow width, to utilize the capacity of the trolley cars.

The overhead conveyor descends from the roof of the manufacturing building to ground level as it crosses a courtyard and, through a system of turns, enters the warehouse which is provided with nine stations, including one wrapping station and eight storage areas.

A panel board at the scales in the manufacturing building is the nerve center for the entire conveyor system. The scale operator can select a roll of paper from either slitting machine, move it to the scales, check, weigh and mark it, move it onto the transfer car, and to the overhead trolley car. He selects the discharge station in the warehouse by a pushbutton.

Another control panel is located at the wrapping station, the first station in the warehouse. Paper that is to be wrapped is discharged and, after wrapping, is returned to the overhead conveyor at a load station between discharge stations one and two. The selection of storage area for the wrapped paper is made at the second control station.

Three particularly interesting automatic devices in the system are the scale, the transfer unit, and the car tilting device.

The scales and belt conveyor are built into a unit. The conveyor consists of a drive unit, an intermediate section (attached to the beam of the scales) and a belt take-up unit. The three are connected by an angle belt. The scale has two printing type dial heads and is equipped so that a load may be registered on either dial. One dial prints red, the other blue, so production from each slitter may be noted.

The transfer unit allows two-way movement. It consists of a section of live roll conveyor mounted on a carriage which moves at right angles to the direction of flow of the roll section. The carriage moves the roller conveyor between a position in line with the belt conveyor to a position adjacent to the car of the overhead conveyor. The roll of paper moves from the scales to the transfer unit where it strikes a limit switch, at which point the live roll stops.

When an empty car on an overhead conveyor moves into loading position, the roll conveyor moves laterally to the car and one side elevates causing the load to move onto the car. An air-actuated bumper snubs the roll and brings it to rest on the car without shock or damage to the load in the conveyor.

The unloading is done by a system of solenoids and limit switches. The scale operator selects the warehouse station by pushbutton. A solenoid actuated arm at the selected station moves into position so that when the particular car moves past the station, an air cylinder will tilt the bed of the car causing the load to roll into storage. A selection operates only one cycle.

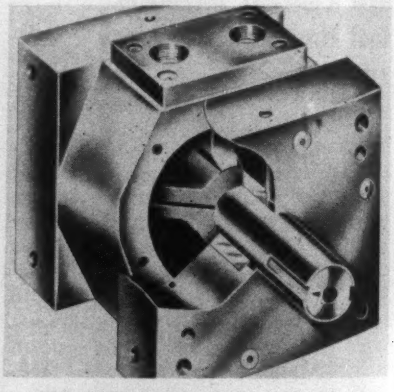
New Laminate Material

ENGINEERING material called Tissuglas paper is now being produced by American Machine & Foundry Co. This film product is essentially microglass fibers to which a binder and/or impregnations can be added to achieve desired electrical, chemical and thermal properties.

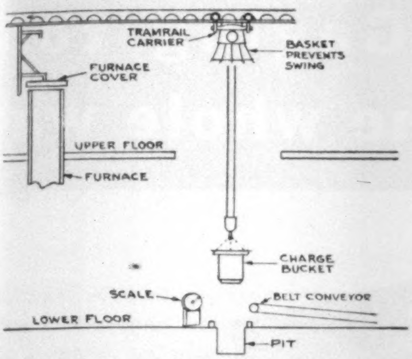
The ultrasoft, tissue-like film is available in thicknesses ranging from 0.5 to 13 mils and widths up to 40 inches. When specified, the binder utilized is insoluble in aqueous and most organic solvents.

The plain Tissuglas paper can be as much as 95 per cent air by volume, thereby providing industry with a carrier sheet composed of up to approximately 95 per cent resin and the balance inert carrier. Wet strength is approximately 70 per cent of dry tensile which ranges from 95 to 880 psi; breaking strength varies from 200 to 1350 grams per inch of width. Chemical and thermal properties are, to a great degree, determined by the basic glass fibers in combination with the particular impregnation used.

Potential applications include surfacing sheets for high and low pressure laminates, as well as backing material for a wide variety of other volume-production sheet products, notably mica.



OSCILLATING torque motor has been developed by Roto-Mation Inc., Greenville, O. Unit is capable of providing up to 280-degree rotation for turning, opening, closing, clamping, indexing, feeding, etc. The motor operates with equal efficiency on air, oil, or any fire-resistant fluid. Rotative speeds are limited only by the fluid pressure



CYCLE OF OPERATION:

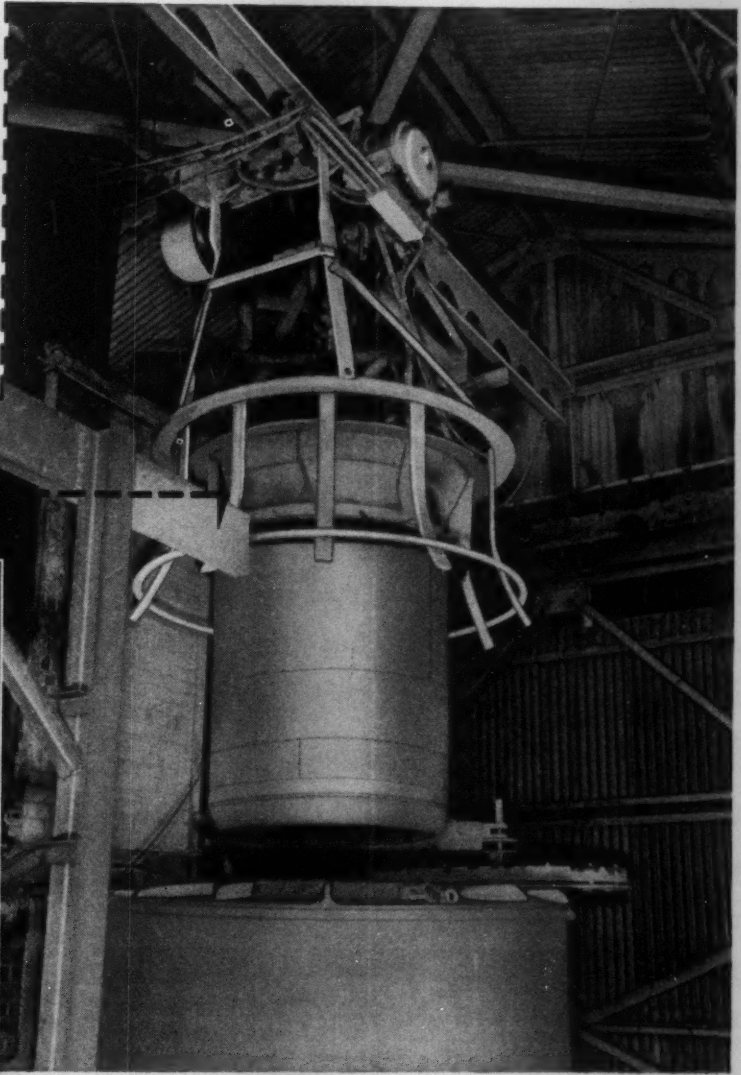
1. Bucket in pit filled by belt conveyor.
2. Operator presses start button.
3. Hoist lifts charge bucket to carrier.
4. Carrier moves only when bucket is in high position.
5. As carrier approaches furnace it swings cover away.
6. Bucket lowers into furnace and empties.
7. By reverse series of operation bucket returns to pit.

From Time Bucket Leaves Pit until it Returns, All Operations are Automatic

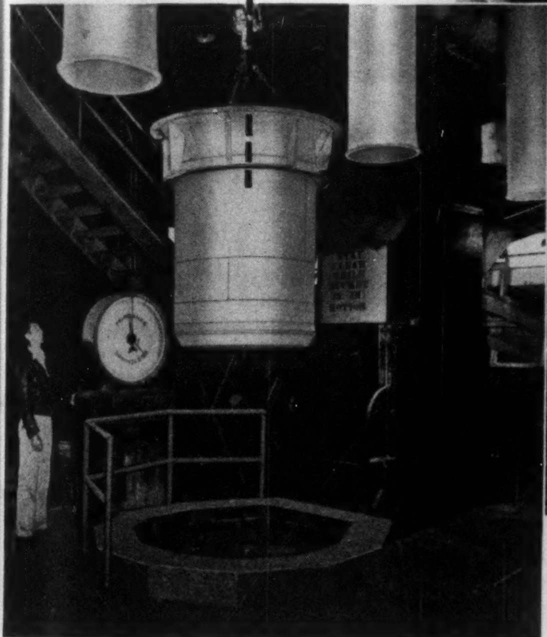
Melting Furnace Charged Automatically

One Man Takes Care of Entire Furnace-Charging Job

Tramrail carrier over furnace with bucket starting descent.



Bucket on way up from pit.



BUCKETS loaded with 2000 lbs. of charge materials consisting mostly of old battery plates are delivered from weighing scale to melting furnace, emptied and returned automatically by means of a Cleveland Tramrail Automatic Dispatch System. The entire furnace-charging job is taken care of by a single man.

This simple, easy method of furnace-charging is one example of the variety of ways Cleveland Tramrail Automatic Dispatch Systems are aiding many companies in different fields to raise plant efficiency, cut costs and improve safety.

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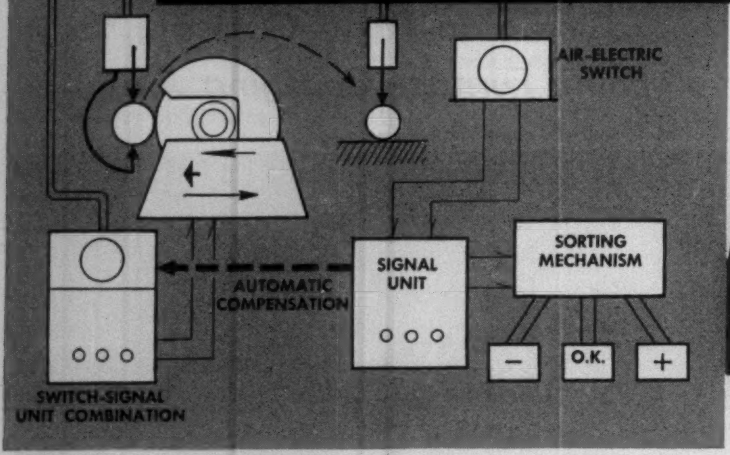

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We work closely and successfully with machine tool builders to develop gages that conform to the capabilities of their machines. Our engineers provide various degrees of control on existing machines in the field and also work in close collaboration with machine designers to provide gaging and control units built into the manufacturer's original machines.

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Our goal is the development of the one best gage for any job, in the fastest time, at the lowest cost. We are widely experienced in mechanical, air, electric, and electronic gages . . . and are regularly designing and building them all. If gaging in your plant can be automated, chances are good that the right Federal Gage will really make Automation pay! Write or call us today.

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detroit dateline

By **JAMES C. KEEBLER**
Associate Editor

Big-League Automation

MACHINE SHOPS in general look to the automakers as a sort of major league of manufacturers. Their production teams work on the big budgets, play for the big crowds, get the headline publicity, and uphold the traditions of the sport. Though many of the farm clubs operate in the shadow of the front office management with players that aspire to a place in the big show, not all of the minor circuit boys are itching to play big-league ball.

Yet most everyone involved in this great national pastime is an interested fan, eager to follow the team standings, check the box scores, and pick up a few pointers on how to play the game.

General Motors Engineering Journal, "for educators in the fields of engineering and allied sciences," is published every other month by the biggest club in the big-time circuit to give the training camps an up-to-date picture of the results of GM research and engineering developments both in the product and production fields. Watching the trends of the contents of this publication gives an inside view of the infield strategy: Greater engineering emphasis on the development of automatic operations for manufacturing processes.

Engineers Wanted

In the March-April issue of the GMEJ, Mr. J. J. Cronin, vice president in charge of manufacturing staff, is called on to explain in the face of the engineering shortage, "Why is it that you are using so many graduate engineers in the manufacturing side of the business?" In a double-barrelled answer he explains that:

1. The products are becoming a complex combination of electrical, hydraulic, electronic, and mechanical units with the inevitable result that " . . . successful manufacturing depends more and more on the trained mind for the solution of the daily problems which face the production supervisor." The graduate engineer is best equipped by training to supply the required " . . . well disciplined analytical approach."

2. In exercising his right to follow the "urge to find the field of greatest personal attainment and achievement without regard to the path followed in receiving his formal education," the engineer finds that in this type of work he can capitalize on his talents to the fullest.

Spring Training

Lee R. Baker, director of the Chrysler Institute of Engineering told the SAE at Purdue to put the brakes on specialization in undergraduate training of engineers. Give him a rookie trained in logical thinking, basic facts, and principles and he'll put him through a spring training that will give the kid a feel of all the positions before he decides to be a shortstop for life.

A survey of the 1950-52 mechanical and industrial engineering graduates of five colleges and an industry survey of 1050 companies in metalworking and related activities has led the ASTE to announce that as these recent graduates complete their training stint in industry one out of three is being assigned manufacturing engineering responsibilities.

Get In There and Hit!

Automation thinking is often of a high order of complexity. It is seen that the advent of new types of machines, handling devices, interlocking control circuits, and automatic production processes make the use of engineering talent mandatory for the successful pursuit of the manufacturing operation.

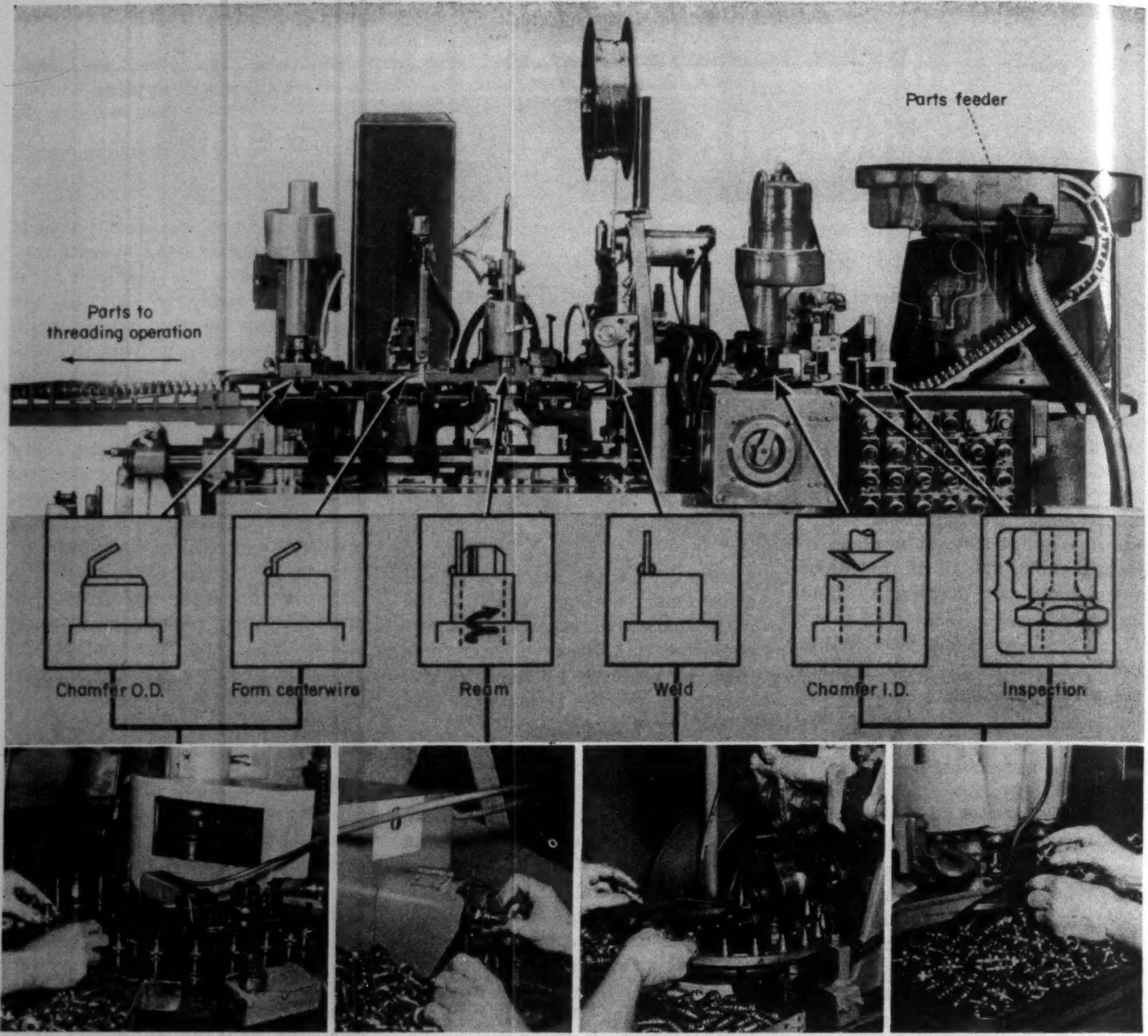
So we have the processing engineer of today looking at the handwriting on the dugout wall. He is expected to provide the necessary production processes, machines, tools, and paperwork to enable the shop to get out the required production as automatically as possible. He must dream up new processes to make new products and put them into operation with the minimum of "cut and try" process development work. Besides a thorough background of manufacturing techniques he must know his (and the potentially available) equipment and the components of which it consists.

Boxing the Score

Howard L. Roat, director of production engineering at AC Spark Plug Division sees a trend " . . . toward the mechanical handling of a part or assembly of parts in such a manner that human effort is not required to transfer parts to perform a sequence of operations. It sometimes includes both the automatic unloading of one machine and the automatic loading of the next.

Automatic devices include mechanisms that are designed to push, pull, rotate, grasp, and lift parts and those that load parts for machining, assembling, welding, brazing, and inspecting operations. These devices are timed to coordinate their movements with the speed of the process and ordinarily are completely automatic while in operation or require only a minimum of manual handling . . . some of AC Spark Plug's early accomplishments in this field included a rotary-type machine for welding the side wire to spark plug shells."

Explaining the role of engineering in this field Roat states: "Quite often a finished piece of automatic machinery is made of standard parts, such as conveyors and air,



Courtesy, General Motors Engineering Journal

Straight-line machine at top handles spark plug shells and performs operations (right to left) shown at center. This development replaces monotonous hand-loaded operations pictured at bottom.

hydraulic, and/or electrical controls set up to obtain the proper sequence of operations. And often, the engineer will design and supervise the building of his own machinery within the plant itself and with no outside parts or help."

The straight-line type machine illustrated shows an improvement on earlier developments in the manufacture of spark plug shells. It combines operations and eliminates monotonous, repetitive loading and unloading that were previously performed by hand. Spark plug shells received from primary operations are placed in the hopper at the right of the machine and automatically fed to two successive inspection stations.

Next station removes cutoff burr by chamfering the inside end of the shell. The welding station feeds the side wire into place from a continuous coil, cuts it to length and butt welds it to the shell. Weld flash is removed from the inside by a reamer at the next station. This wire is then formed to the required shape. The outside burr and weld flash are removed by a chamfering operation on the O.D.

The transfer mechanism of this machine transports the continuous line of shells to each station where cam operated guideposts raise each workpiece into position for the individual operations.

Double Play

Any manufacturer that can combine several of his operations into an automatic cycling machine has a good chance of bettering his standing by a few percentage points.

Even in the bushleagues where the team can't afford a string of professional coaches, trainers, and bat boys, the infield is on the alert for a chance to make a double play and catch the runner who's already on base.

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Hanna Flo-Set Valves are used to control cylinder piston speeds and operating speeds of many types of fluid actuated mechanisms. They are able to handle air, oil, water and many gases. When used with cylinders, these valves permit independent adjustments of forward and return piston speeds. The diagram at the right shows a typical circuit. Flo-Set Valves make the operation of air cylinders smoother and make cushioned cylinders more effective by building up essential back pressure.

Fluids pass unobstructed in the direction of the arrow on Hanna Flo-Set Valves. In the opposite direction, flow can be controlled from zero to full pipe capacity. One valve can be set to an infinite number of controlled flow positions. Once set, the position can be held by means of a locking collar. Established flow positions can be reset by using the micrometer graduations which accurately measure flow as a percent of full pipe capacity.

One revolution of the aluminum valve body will change the flow rate from zero to full capacity. No tools are necessary! In addition to the standard ¼", ⅜", ½" and ¾" sizes, there is a ¼" Jr. model, without micrometer graduations or locking collar, for light piping and tubing.

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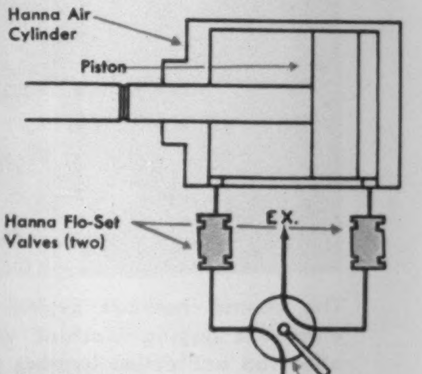
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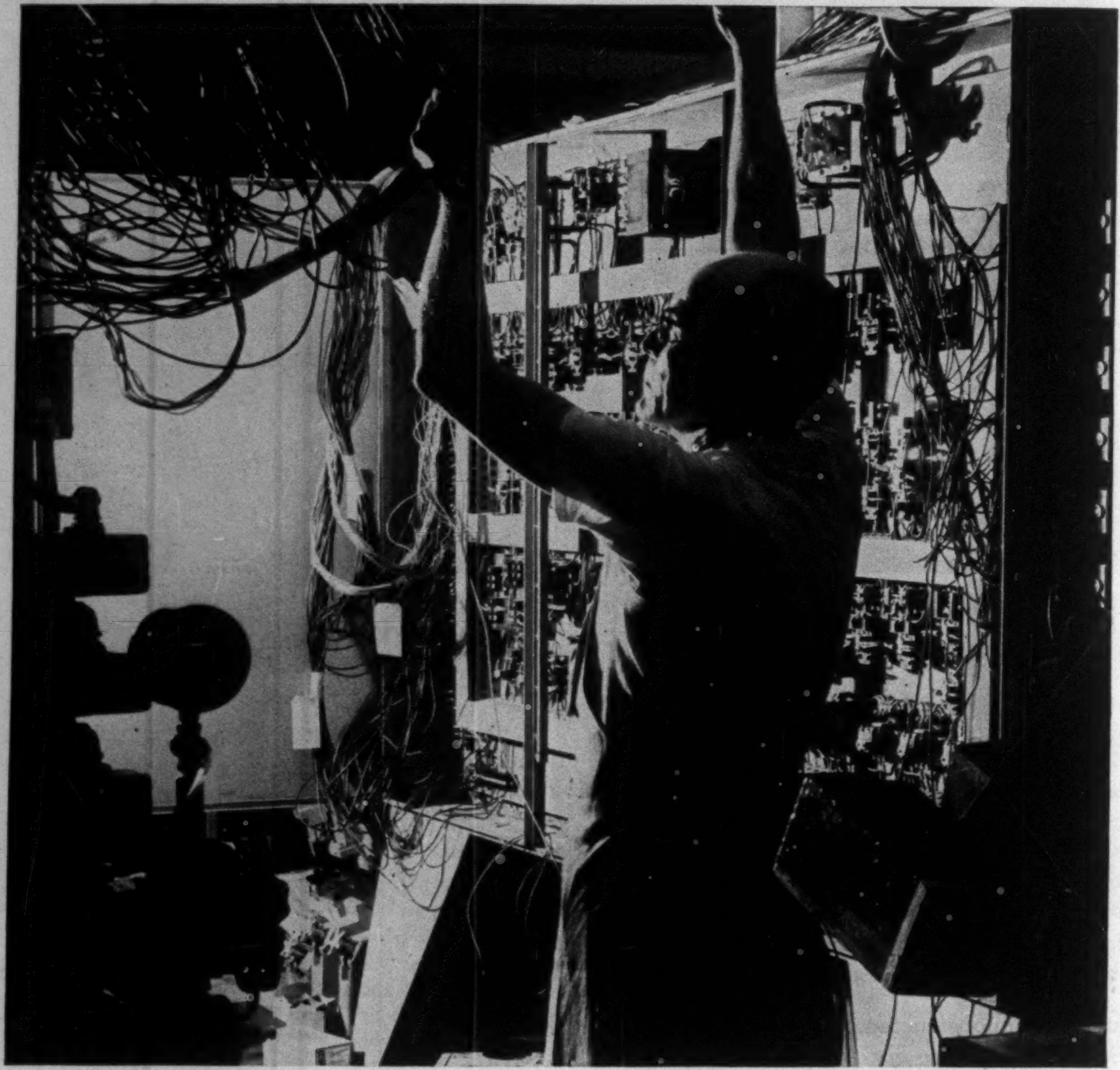
* AUTOMETROLOGY



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AUTOMATION

Integration for Results

One of the primary aims in plant automation is the achievement of continuous, balanced movement of material or work through the desired processing stages. Basically, three key phases are involved in developing automatic production lines. These can be reduced to: (1) The processing steps or machines, (2) the automatic control arrangement and (3) the handling system or devices. Suitable results are obtainable only through careful integration of all three phases.

In developing plant installations, it is imperative that the handling phase be given sufficient consideration. Where operations involve continuous webs, the handling problem has proved to be far less difficult than that where separate pieces or bulk products are to be processed. However, accomplishments in the latter area in the last few years reveal solutions for a tremendous array of other problems.

Besides handling the product within the individual processing operations there is always the problem of transfer between operations. Today the possibilities in automatic handling systems include floor conveyors, belt or wire mesh conveyors, air tubes, overhead or trolley conveyors, air or hydraulic cylinders, walking beams, shuttle bars, vibrating or oscillating conveyors, pivoting and rotating mechanisms, and storage or stacking devices. The fundamental rule is to keep close control of material being processed; to lose control is costly.

A wealth of experience and know-how is available for achieving successful integration of handling into the overall automation scheme. Specialists in this growing field of endeavor have been actively translating effective techniques from one industry to another, and breeding new results from old ideas.

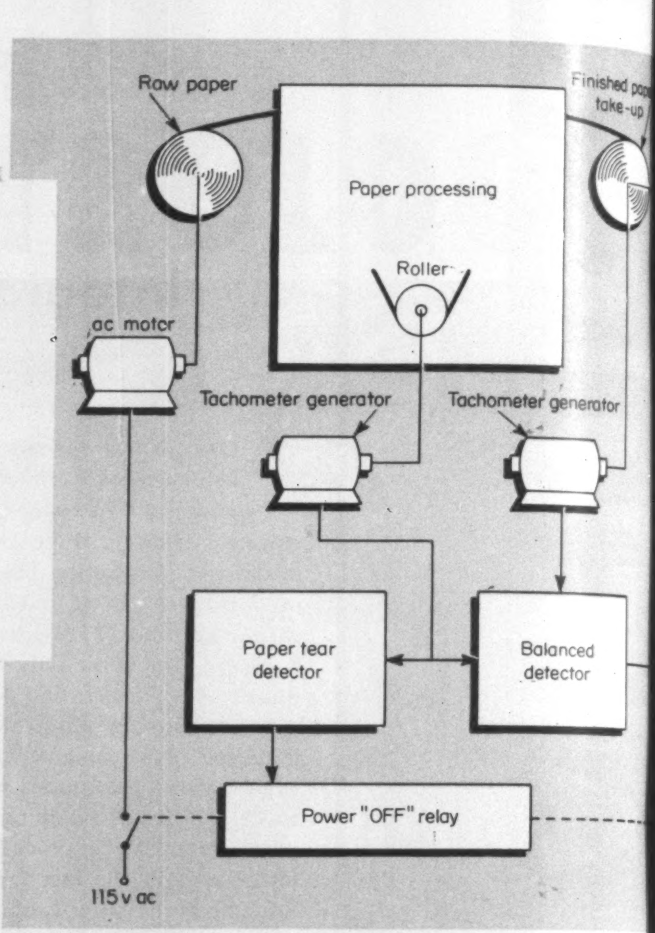
Opportunities for improving handling operations are unlimited. Significant cost reduction achievement for the future lies in making more automatic the handling, storing and distribution of materials and work in process.

EDITOR

AUTOMATION RIGHT NOW

BY MODIFICATIONS OF EXISTING EQUIPMENT

By WALTER H. BUCHSBAUM
Electronic Consultant
Bellerose Manor, L.I., N.Y.



PRESENT PROMINENCE of the magic word "Automation" in the press releases from Washington to Detroit has many progressive business and management executives re-examining their company's position. In many instances they look upon the magic "A" with the awe that the average home owner displays towards the job of furnishing the Empire State building. Unfortunately their concern and confusion is quite justified by a casual glance at the popular press. Automation in print often takes the form of vast pushbutton panels controlled by midget size semimorons producing anything from toy sailboats to these vast pushbutton panels. The awed executive cannot but envision the conversion of his own well planned, fully manned, profit making operation into an expensive, soulless monster which will eat up all previous capital investment and continue to feed on vague future profits. Our readers need not be reminded of the true nature of the process recently popularized by the magic "A".

Those of us who design and develop individual automatic manufacturing systems are often in the position of explaining the true nature of the beast to a sceptical management which is torn between the desire to completely revise a particular process and the need for only improving the existing facilities. Often management is reluctant to shut down for some period in the hope that the new process is really better than the old. In many instances the capital investment in the "obsolete" equipment has not yet been depreciated, or else it seems wasteful to scrap machines which are still returning a decent profit. No amount of theoretical argument can convince such management that their outdated methods must at once be replaced by "pure" automation. Often a more modest improvement plan is rejected as being not worthwhile in the face of the "pure" automation looming on the rosy horizon.

Speed and Tear Control

Unless one has witnessed the benefits derived by relatively minor and inexpensive modifications, the value of such half-way measures is hard to realize. When, as example, a $50,000 machine requiring two operators is converted to unattended operation and a more uniform product, management ceases to look on automation with jaundiced eyes and will embrace both concept and implementation with full confidence.

A few years ago the author had occasion to consult with a well known carbon paper manufacturer concerning the possibilities of improving the product. It was found that the carbon coating machines were completely under manual control. Some of the functions such as constant paper speed control, instant stopping in the event of torn paper, heat control, etc., could be performed by an array of standard electronic controls. These controls,

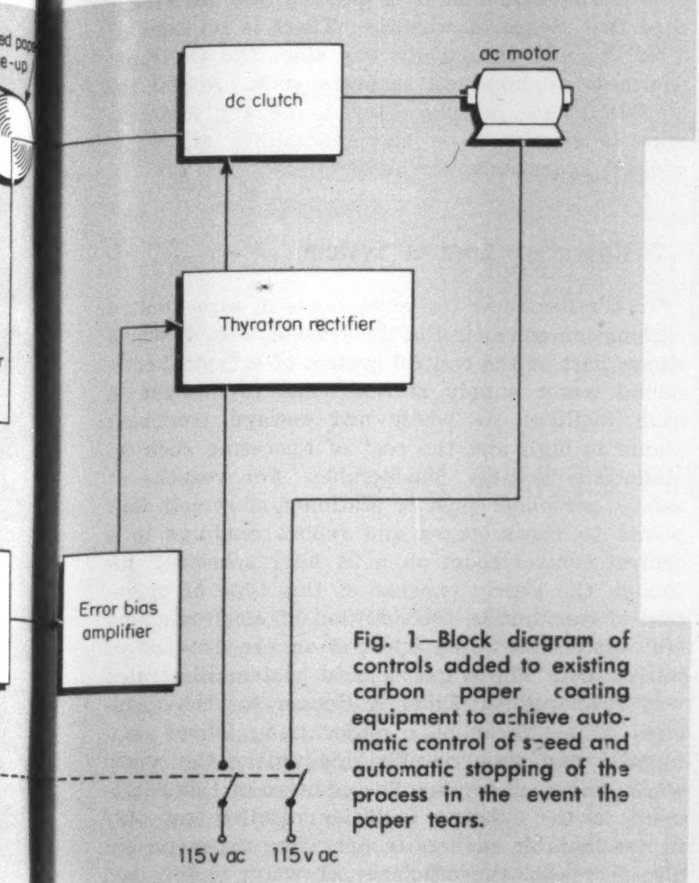


Fig. 1—Block diagram of controls added to existing carbon paper coating equipment to achieve automatic control of speed and automatic stopping of the process in the event the paper tears.

Must the benefits of automation be claimed only by those organizations involved in large capital expansion programs? This author says, "No" and gives examples of the great value in the partial automation of present operating equipment.

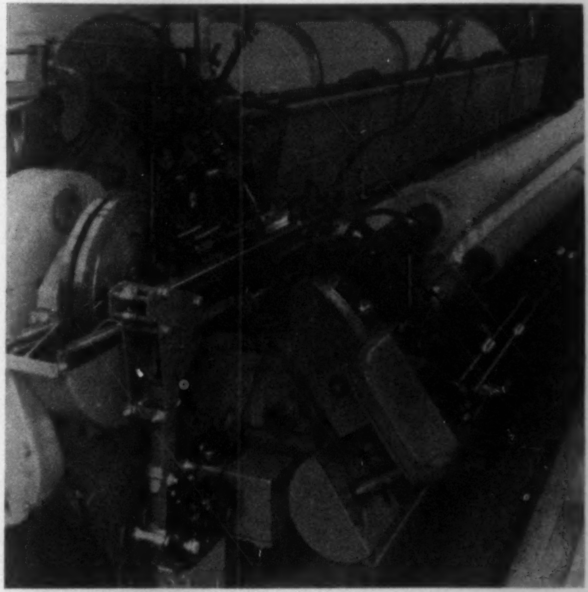


Fig. 2—Photocell fabric scanning stop motion device installed on a Reiner tricot knitting machine detects presence of broken thread. Scanner carriage is powered by motor in foreground and traverses full width of machine on its own rails making this control device a self-contained machine attachment.

Fig. 1, could be added to the machine without altering the coating process or the rest of the operation. One coating machine was temporarily hooked up for electronic control and within a week management was convinced that substantial savings and greatly improved carbon paper would result. Only a few months later the entire bank of ten coating machines was electronically controlled with continuous monitoring at a central panel by a single operator.

The conversion cost per machine was in the order of several hundred dollars. Substantial savings in wages were paced by more uniform quality, shorter lengths of tear-spoilage and generally smoother operation. Maintainance of the electronic control system can be performed by the regular plant electrician. Needles to say, this manufacturer is sold on the use of electronic controls. In fact, he now maintains his own industrial electronics department which continues to investigate the application of automatic controls to other processes.

▶ Tireless Monitoring

Another example of the application of a relatively minor and inexpensive modification to existing equipment is illustrated in *Figs.* 2 and 3. Here a Reiner tricot knitting machine has been improved by the addition of the Photobell fabric scanning stop motion device. This unit is comprised of a light and a set of photocells moving back and forth along the transverse track. The light reflections from regularly spaced threads result in a pulse train output from the photocells. When a thread breaks, the pulse corresponding to it is missing and the control unit stops the machine and gives a visible and audible alarm. The actual circuitry is complex since good stability and noise immunity

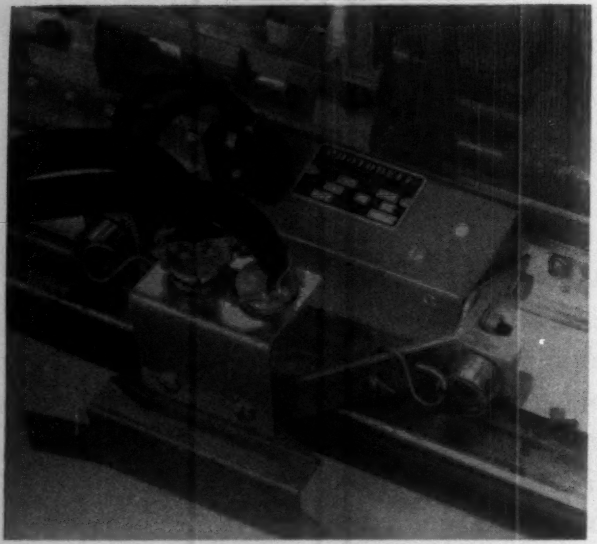


Fig. 3—Scanner carriage and electronic unit of attachment shown in *Fig.* 2. Light reflections from regularly spaced threads result in a pulse train, which when interrupted by a thread breaking, causes the control unit to shut down the machine. Cam bracket on the carriage actuates limit switches to reverse the traversing action.

are required from the phototubes as well as the pulse detector, but basically this unit presents no mysteries to the electronics engineer. The introduction of this rather simple addition to existing knitting and weaving facilities has resulted in substantial benefits. Personnel requirements for inspection of goods are greatly reduced, yet the material is inspected much closer and more frequently during the knitting process. Defects which ordinarily spoiled an average of eight to ten inches of material with human inspection now rarely exceed two inches of wastage. There is no need to alter the machine in any way since the electronic device is mounted on separate rails. Actual installation time is only a few hours and maintenance is simplified by the availability of standardized spare subassemblies.

Fig. 4—Field pumping station of a community water supply system showing local controls developed by Taller and Cooper. Telemetering systems added to existing installations permit manual control as well as local and remote electrical operation.

▶ Operating Control System

To further show the advantages of even limited automation consider the illustration, *Fig.* 4, which shows part of the control system of a typical communal water supply station. The investment in such facilities as water and sewage treatment plants is high and the cost of operating such installations is also considerable. For reasons of safety, personnel must be stationed at remote flow points to check gages and report readings to a central control room on a 24 hour schedule. Although the yearly expense of this type of operation is substantial, the addition of electronic control systems is often opposed on the grounds of initial cost. The water control system illustrated was developed by Taller & Cooper for the municipal water works of a major Long Island community, and was installed long after the water works had been in use. The addition of this equipment to the existing facilities resulted not only in considerable savings in operating expenses, but also increased the efficiency of water supply and eliminated frequent low pressure complaints during periods of maximum water demand. The telemetering system permits manual control as well as local and remote electrical operation of all valves and pumps and provides continuous monitoring of the condition of every part of the system at a central control point. It is further possible to permit completely automatic operation or, if needed for emergencies, to remotely direct the opening or closing of any valve.

▶ Automation Right Now

While we intend to emphasize the great value of even partial automation of existing facilities, we do not mean to detract from the obvious advantages of being able to design a complete process for automatic fabrication. The point we cannot stress too much is that reasonable management cannot be expected to blindly abandon proven techniques in the hope of future benefits predicated on large current capital investments.

Successful installations of limited automatic controls usually are the best argument for full automation. The savings realized from such partial automation will often provide the incentive and even the capital for a more complete redesign project. Those valiant engineers whose burning enthusiasm for the ultimate in automation tolerates no half-way measures should remember that even they had to learn to crawl before attempting to walk.

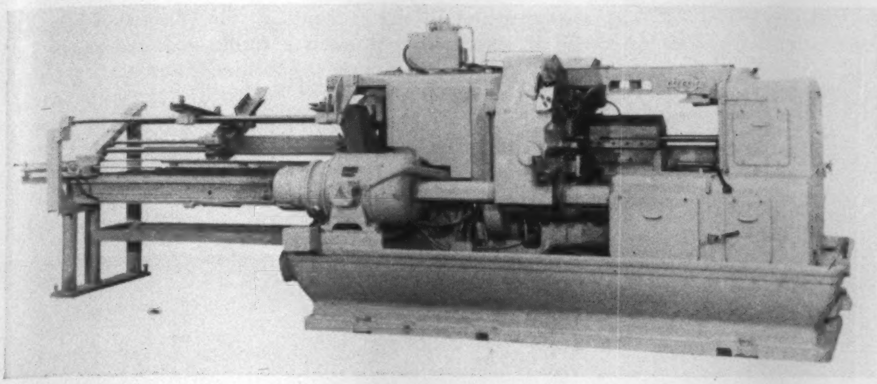


Fig. 1—This standard Greenlee 1⅝-inch six-spindle automatic was fitted with a special feeder. It machines one or both ends of a precut ¾-inch round steel shaft. Operations are performed in 11.5 seconds per shaft. A cutting speed of 112 sfm on the OD is used, and toolslide stroke is 9/16 inch with feed of 0.0064 inch on the endworking tools.

LONG PARTS FED AUTOMATICALLY

AUTOMATIC TURNING of metal parts is one of the areas in which progress toward automation has been going on for a long time. One of the developments illustrating this point is the automatic turning machine described here. High-speed machining on precut ¾-inch diameter shafts 39 inches long is performed by this standard automatic unit with special stock feeder, shown in *Fig.* 1. Operations on 313 pieces per hour include forming of a taper and circumferential groove, serrating a diameter, and threading a section which is chamfered and relieved.

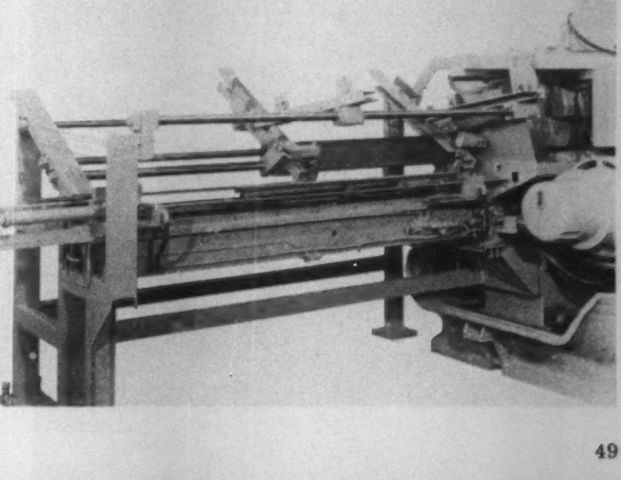
Shafts can be loaded into the adjustable V-type magazine, *Fig.* 2, from either side of the machine. A releasing mechanism actuated by a mechanical linkage from the cam drum of the machine drops the shafts one at a time into the loading cradle. A loading head operated by an air cylinder equipped with a Hydro-Check loads and unloads the collets at the sixth position. As the new shaft is fed into position it pushes the machined shaft onto a live-roll attachment which delivers the finished shaft to an outfeed hopper. Relation of live-roll speed and travel of the loading head is such that the finished shaft is accelerated away from the new shaft so an air-operated stock stop can drop between them and position the new shaft.

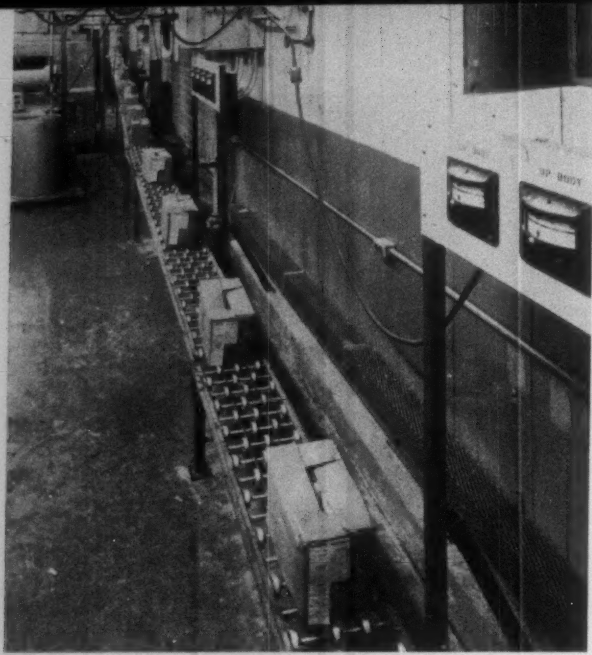
Actions of the feed mechanisms are electrically interlocked by limit switches so that if any one of them fails to function normally the machine automatically stops. Air cylinders in this installation are controlled by cam-actuated valves operating in conjunction with an air bleeder system.

This machine can also simultaneously perform a turning, facing, or drilling operation on the opposite end of a shaft, providing the shaft is long enough to project beyond the feed end of the spindle assembly. A tool holder for such an operation rides on gibbed ways at the rear of the fourth spindle position. Tools in this holder can be moved forward at the required feed and returned by a gear and rack mechanism actuated through a mechanical linkage from the cam drum.

This unit serves to illustrate the type of development which often precedes a completely automated installation.

Fig. 2—Special feeder for the shaft machining job. Rapid feed into the collets at the sixth spindle position is obtained with an air cylinder. Deceleration at end of stroke is accomplished by a Hydro-Check. Finished parts are moved to discharge hopper by a live roll arrangement.





1 Molding department of the Owens Brush Co. where line of presses forms phenolic resins into toothbrush handles. Molded handles are placed in cardboard boxes. Gravity conveyor at the back of the press line allows boxes to flow to an inspection station in the next room.

2 Gravity conveyor loop carries handles to and from workbenches where handle finishing operations are performed. To avoid mixups, tickets on each box indicate the status of work that has been performed on the handles it contains.

AUTOMATION TODAY

3 View of the conveyor network in the first floor central manufacturing area. At specified intervals during the day finished handles are routed to the branch that leads to the inter-floor conveyor which moves them upstairs for storage.

HANDLING TOOTHBRUSHES

WHEN PLANNING a new installation, the necessary study of present methods often uncovers facts that indicate unsuspected inefficiencies. Such a study at Owens Brush Co., when planning consolidation of several operations into one three story plant, yielded the fact that it took 152 days of in-process flow time to make a toothbrush—this caused high in-process inventory; involved 72 separate transfers of units, 33 inspections and 45 temporary storages. Space was lost to bulky transportation equipment as well as product storage.

A system built around Rapistan conveyors, made by the Rapids Standard Co., has improved handling to the point where in-process time has been halved, more floor space made available for brush production, materials handling costs reduced and a better end product produced.

After toothbrush handles are molded, they are transported by gravity conveyor from the molding

4

As production schedules require, handles are sent to the machine room for the insertion of the brush material. Each completed pallet-tray load is placed on the gravity conveyor to go to a spot-check inspection station in this room.

Private brand names are stamped on brushes on this third floor spur line just ahead of the power belt conveyor which carries finished brushes and packing material down to the first floor. Incorporation of this custom operation into the complete conveyor system has served to eliminate confusion.

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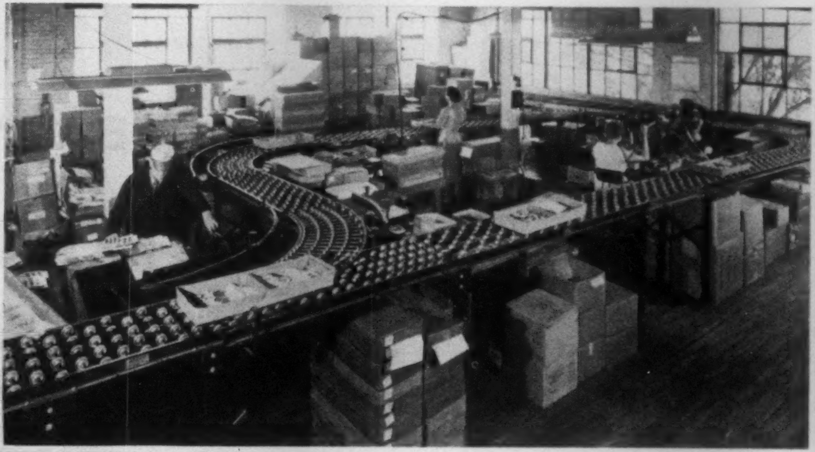

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Packed brushes go over first floor traffic lane on a bridge consisting of two power belt conveyors linked by a gravity conveyor. Next stop is the shipping dock where boxes are diverted onto portable section of wheel conveyor that carries them into waiting truck.

department to an inspection station. After inspection, the box of handles is placed on a gravity conveyor laid out in the form of a loop. During the course of travel around the loop, boxes are removed and handle finishing and stamping operations performed. At the completion of these operations, boxes are transported to a spot-check point for inspection. Handles that fail to pass inspection are returned to the finishing operations on the conveyor loop. Tickets on each box indicate the extent to which each box of handles has been processed.

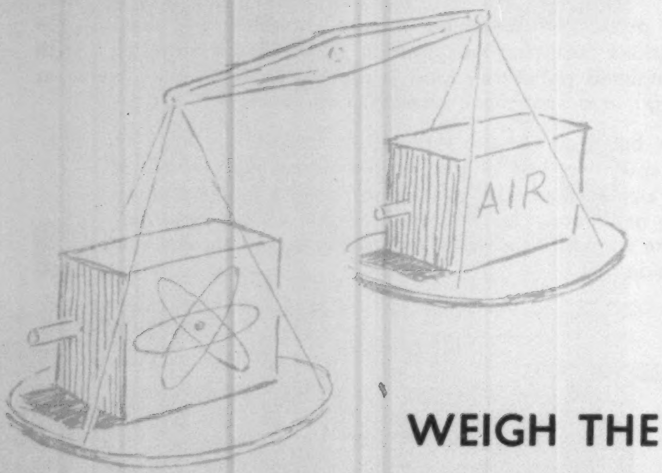
At completion of handle making operations, handles are removed from the conveyor and placed on pallet-trays by item and color for temporary storage. At four scheduled intervals during the day, the handle making department has exclusive use of the general plant conveyor line which permits handles to be transported from temporary storage to finished handle storage on the second floor. At this point, handles are taken from the conveyor and stored until scheduled for further processing.

Each morning, orders are filled for the brush making department. Boxes of handles are removed from storage and transported to the proper machine for filling. At completion of the filling operation, brushes are placed in trays. Machine operators place filled trays on conveyors that transport them to the spot-check station for inspection. Then they are conveyed to the third floor by gravity and a power belt conveyor. At this point the brush manufacturing has been completed and brushes are put into storage until an order is processed for packaging.

When a packing order is issued, both brushes and packing material are taken from storage and placed on the conveyor together. The complete order of brushes and packing material are conveyed to the proper packing line.

In addition to achieving advantages of reduced in-process flow time and greater available floor space (enabling a doubling of sales volume with only a 30 per cent addition to the plant) Owens Brush Co. has found that this step toward automating their plant has keynoted organizational advantages too. These include easier methods study of production operations and an improved accounting system of cost control plus the employee morale benefits that accompany tidy housekeeping.

Features of conveyorization of this plant are shown in the accompanying photographs.



A competitive battle is brewing between the proponents of pneumatic control and those of electronic control. Here is the electronics case — admittedly only one side of the story. Here also is a challenge for the other advocates—to present the pneumatic side.

WEIGH THE ADVANTAGES OF

ELECTRONICS FOR PROCESS CONTROL

By KARL W. PETERSON
Manning, Maxwell & Moore Inc.
Stratford, Conn.

USERS of industrial process instruments and controls may begin to think that they will never have the answer. They barely become accustomed to a particular type of instrument system before the whole picture changes. Just a few years ago conventional round-chart recorder controllers were in general use. Then miniature or graphic type instruments were offered, and the approach to instrumentation was altered. Now, in the midst of the change to graphic instrumentation, users are being asked to consider change from pneumatic systems to electronic instruments, *Fig*. 1. Such is the price of progress.

Of course, nobody will ever have *the* answer. The new instruments are being offered to meet known requirements and specified demands, to improve performance. The story of what instruments have done for industry is too old to be repeated. But sometimes it does seem necessary to point out that the story is still far from concluded—if there is

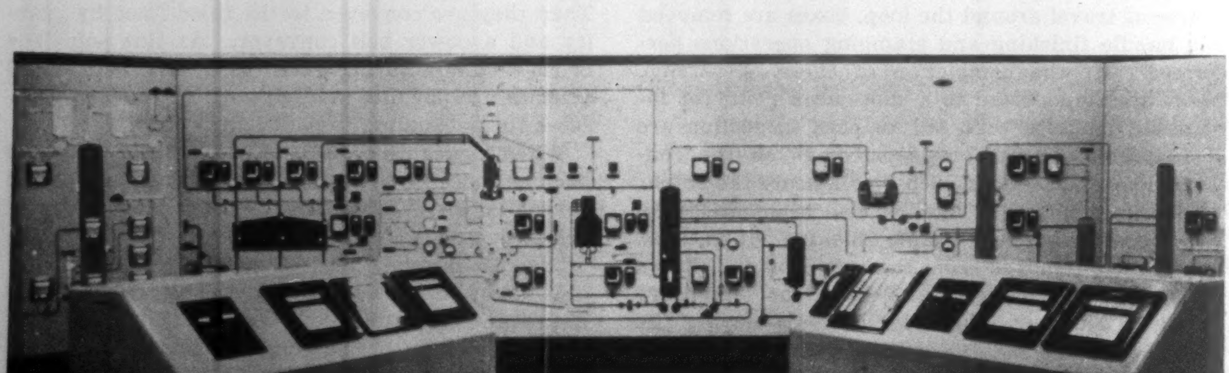


Fig. 1—American-Microsen control system graphic panel installed at the Pointe au Tremble, Montreal, P.Q. refinery of Canadian Petrofina Ltd. In the foreground are the data readout system and multipoint recorders.

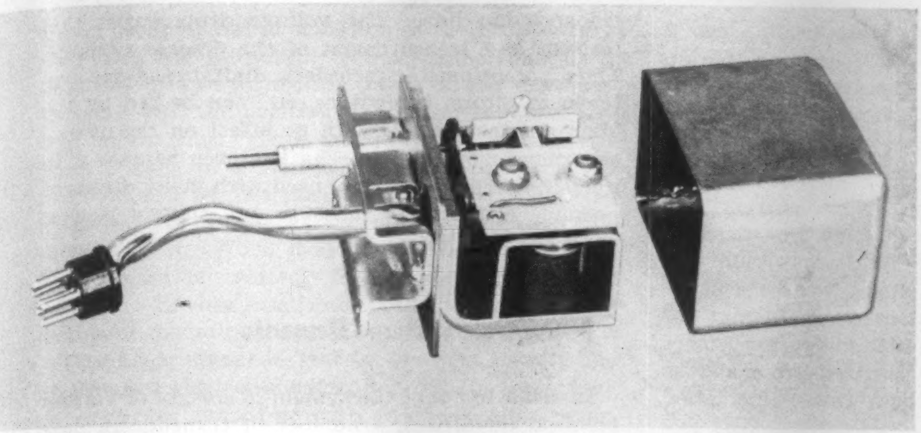


Fig. 2—Microsen balance is a transducer which converts a mechanical or electrical force into a dc signal. This instrument is a wartime development originally used for aircraft engine control.

a conclusion. There are still many requirements that some present-day instruments have not satisfied.

Some process variables cannot be adequately controlled because present instruments are too slow to handle them. Even when a chart record shows smooth control, that often is because the instrument is not responding to the actual fluctuations. Artificial capacities are still built into process equipment to make control possible. This increases cost of equipment and reduces productivity.

Data on the process variables and operation are not presented in a readily usable form. The chart records and log sheets must be analyzed and translated by human interpreters. This takes money, causes delay and adds the possibility of human error. Start-up and downtime could be shorter. Reducing these factors alone can save the cost of the instrument equipment.

Location of instruments is compromised by limitations in transmission distance. It is necessary to place some controllers in the field instead of in the instrument room where they belong. Installation cost often equals or exceeds the cost of the instrument equipment.

Several of these shortcomings have been overcome by new electronic control systems which have speeded measurement and control responses, and decreased transmission lags. Distances of up to 30 miles now are possible between the process and the control room. These systems are compatible with electronic computers, calculators and business machines that are being used to analyze data and present it in its most useful form. Since these devices are fundamentally electrical, electronic measuring and control instruments are suitable to feed signals to them. This is important because the trend in the plant of tomorrow is toward such automatic data reduction devices

▶ Development of a System

If it is accepted that electronic process control and measurement will be a strong competitor in the system of tomorrow, we should examine some of the ideas and techniques of this type of control. This can best be done by examining a specific system.

Manning, Maxwell & Moore engineers, starting to design an electrical instrument system, had a choice of several types of signals—first, the choice between alternating and direct current. Direct-current instruments would generally be more expensive to build but would have a number of advantages. Inherent accuracy would be better, and they would not be affected by induced current from the ac power circuits that cob-web most plants. This would allow using unshielded transmission cable—even placing the signal wiring in the same conduit with 115-volt, 60-cycle lines. Resulting lower installation cost would more than offset the higher cost of equipment.

Having chosen direct current, the engineers settled on a current type of signal in preference

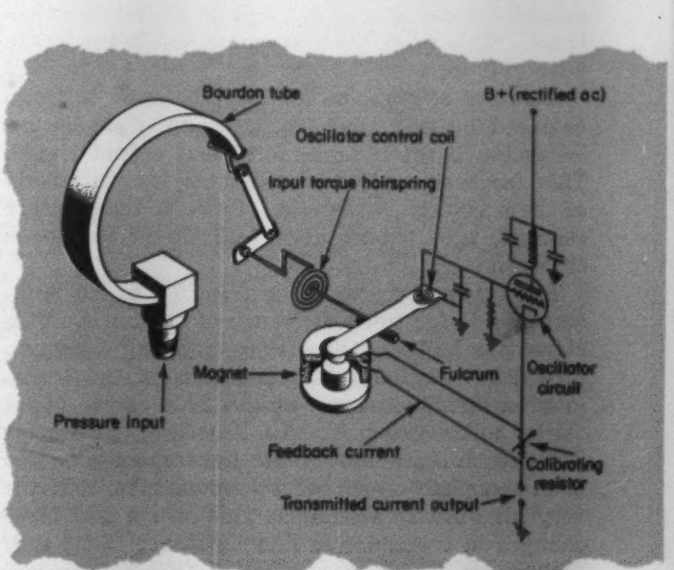


Fig. 3—Transducer used to convert an input pressure signal to a dc output signal. Movement of the beam detunes an oscillator which is in the grid circuit of a vacuum tube. The output current signal is carried in the plate circuit of the tube.

to voltage or time-pulse. First, a current signal is continuous; time-pulse is not. Next, current signals can be compensated for changes in transmission line resistance more easily than voltage signals. Third—and this point appears to be a paradox—the engineers employed a current signal because most electrical devices with which the American-Microsen System would be used are made to fixed voltage ranges. More on this point later.

Obviously, conventional dc movements like the D'Arsonval could not be used; they are too delicate for industrial service and produce too little power to operate stable, rugged systems. A servoamplifier is required to magnify the tiny signal (motion or force) produced by most measuring elements. Actually, the choice was easy because Manning, Maxwell & Moore had such a device in an aircraft engine control developed during the war. It had been arduously tested in this severe service and had other suitable features for industrial use. This simple electromechanical servomechanism, called the Microsen balance, is the heart of the American-Microsen System.

Purpose of the Microsen balance, *Fig.* 2, is to transduce a mechanical or electrical force into a current signal. The balance consists of a light, dynamically-balanced beam with flexure pivots. Input force from a measuring element causes one end of the beam to move in the vicinity of a tuned oscillator coil. Movement of the beam causes detuning of the oscillator so that more or less current flows through a vacuum tube associated with it. This current is the dc signal of the Microsen transmitter. A portion of it is fed back to a coil in a magnetic field near the free end of the Microsen beam. This produces a force on the beam to oppose the input force and move the beam back toward its original position. The beam is force-balanced by this feedback, assuring a precise relationship between input force and output signal. This feedback system compensates for the effects of line voltage variations, ambient temperature changes, tube deterioration and circuit resistance changes.

The transmitted signal is from 0.5 to 5.0 milliamperes dc for full-scale range of the input. This signal can be transmitted over very long distances, provided that the total resistance of the transmission circuit does not exceed 3000 ohms—about thirty miles using No. 18 American wire gage (0.040 inch diameter). Since the transmission line is in the plate circuit of a vacuum tube, it has a very high source resistance. This means that large changes in transmission line resistance cause very little error in measurement—less than ¼ per cent for 3000 ohms variation. Thus the Microsen balance is free from normal sources of error.

To accommodate accessory devices which have fixed voltage ranges, a calibrated resistor of any value up to 3000 ohms can be inserted into the transmission line. The voltage drop across this resistor is a measurement of the process variable. Thus, potentiometer recorders, digital read-out systems, monitors, computers, etc. can be fed by the Microsen transmitter with no effect on the overall accuracy or operation. The Microsen balance with its associated amplifier is used with many different primary elements to measure and control process variables.

▶ Control System Elements

In order to adapt the system to control of various physical quantities, a number of transducers have been developed. The American-Microsen transmitter is used with Bourdon and bellows elements for pressure measurement, *Fig.* 3. Pressure ranges from 40 inches of water (using a bellows element) to 30,000 psi may be measured. Differential pressure for flow and level indication is measured by a bellows differential unit, provided in ranges from 20 to 400 inches of water, and with static pressure ratings to 5000 psi. Level can also be measured by displacement and float-operated level units. Filled thermal systems for range spans from 50 to 1000F are available. For spans above 300F, thermocouple input transmitters are also used—for temperatures up to 3000F. Electrical input transmitters can be used for voltage or current measurements as low as 100 microamperes for full scale range. They are compatible with most transducers for such measurements as pH, oxygen concentration, gas analysis, etc.

A variety of different types of receivers can be used with these units. Conventional ammeters with a range from 0.5 to 5.0 milliamperes will indicate the signals. Of course, scales are calibrated in terms of the variables being measured—flow, pressure, pH, etc. Millivoltmeters and potentiometers will also indicate or record the signals, as explained previously.

For maximum accuracy and speed of response, a line of American-Microsen indicators and recorders has been developed. These use Microsen balances and operate very nearly as the transmitters. The difference is that the output signal is fed to a rotary solenoid which moves the pointer or pen. Movement of this solenoid also provides the feedback force to rebalance the Microsen beam. Thus, the balance measures pen or pointer position, compares it with the input signal, and eliminates any discrepancies between the two. The pointer is dynamically balanced at the correct reading, driven there by a relatively powerful solenoid.

A logical sequel to measuring and recording equipment is the development of a control system to manipulate the variable which can be measured. The control system shown in *Fig.* 4 follows the miniature, unitized design with all control responses electrical.

First unit in the control system is the indicating or recording set-station. This component serves two functions—it provides indication or recording of the process variable, and provides an output signal proportional to deviation of the process variable from the set-point. The set-point function is obtained by comparing the value of the measured variable with the position of the control-point setting mechanism. This manually set pointer applies a force to a Microsen balance opposing the force caused by the measured signal. When the measured variable is at the desired set-point, the forces cancel. When it is not at the set-point, an error signal is created. This error signal (−22 volts to +22 volts) indicates both the direction and degree of deviation from the desired set-point.

This error signal is sent to the next unit in the system, the electronic controller, *Fig.* 5, essentially an electronic amplifier with feedback circuits arranged to give proportional and reset control actions. When rate (derivative) response is required, a preamplifier is inserted into the circuit to provide this action.

There is, of course, no mechanical link between the recording instrument and the controller. The response of the controller is completely independent of any mechanical movement. Entirely electrical, it is capable of extremely fast control responses. Since the electrical components are easily held within close tolerances, reset and rate settings are calibrated.

Output of the controller goes to a manual control station. This device permits switching from automatic to manual operation of the control valve under start-up or emergency conditions. It is simply a current regulator that under manual operation

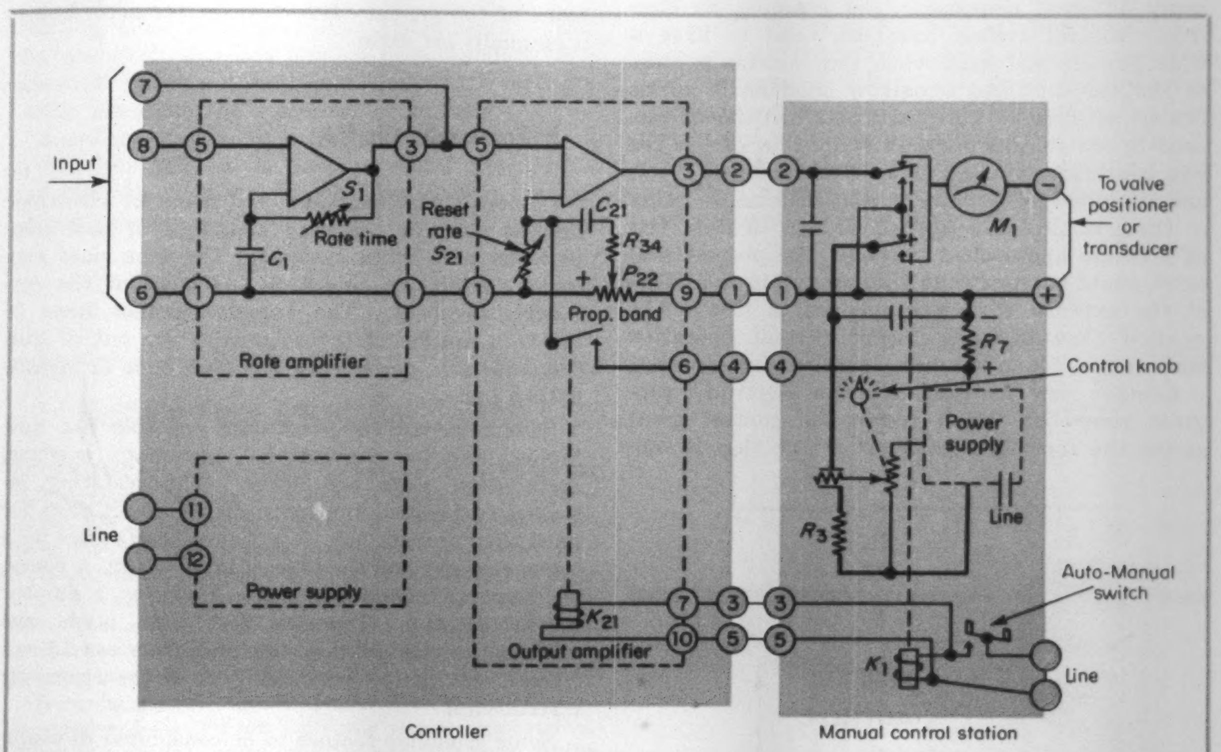


Fig. 4—Elements of a control system from the measurement signal to the output correction signal. Input signal is connected to terminals 8 and 6. Rate action is obtained by delaying the degenerative feedback voltage. For a sudden change in input voltage, there is a large amplification because the feedback voltage is delayed by the action of resistor S_1 and capacitor C_1. Feedback voltage then increases at a rate dependent on the rate time setting until the output voltage exactly equals the input. When rate action is not required, this unit may be removed and the input connected to terminals 7 and 6. Voltage amplification and power output are provided in the output amplifier. Output current flows through the valve positioner and through the proportional band control P_{22}, developing a voltage across the latter. To best analyze the proportional response, remove resistor S_{21} from the circuit. Capacitor C_{21} will operate to resist any change in voltage across it. Therefore, an increase in input voltage will result in an increase in current through resistor P_{22} which will increase the voltage fed back to the amplifier through capacitor C_{21}. The amount of voltage fed back will be dependent upon the proportional band setting. This establishes the gain of the proportional band amplifier. Reset action results when resistor S_{21} is inserted in the circuit. As the capacitor discharges through this resistor, the feedback voltage gradually decreases. However, if the feedback voltage attempts to depart even slightly from the input voltage, the high gain amplifier will increase the output to counteract this departure with the result that the output current will gradually increase. Note that when the input voltage is zero, the feedback voltage is zero. Thus no current flows through resistor S_{21} and the output current remains stationary at some value. The reset rate is adjusted by varying the value of the bleed-off resistor S_{21}.

sends a constant manually set signal to the final control element.

Final link in the electronic control loop is the electropneumatic valve positioner. This device is mounted and linked to the pneumatic unit which moves the valve stem. It transduces the 0.5 to 5.0 milliampere signal to a pneumatic pressure up to 25 psi to operate the valve.

Control Action

Electrical systems can be built to incorporate many different responses. For example, an electronic control system has been built to have a wide proportional band when the variable is close to the set-point and a narrow band as it moves beyond set-limits. This particular instrument was used to control gas pressure while flow of the gas was continuously integrated. The idea was to allow the pressure to vary within reasonable limits so there would be no abrupt changes in flow. But as pressure approached the limit, the proportional band would narrow, thus holding within the limits at the expense of larger changes in flow. The gradual flow changes during normal operation made it possible to integrate with greater accuracy.

Another new instrument is an electronic program controller which resets the control point across the scale electrically at a rate that is continuously adjustable. The rate of programming can be established by a separate signal, as from another controller. This is useful in a process where the pressure must be cycled between limits to create a reaction, but where the cycle must be slowed down if the process temperature exceeds a safe value.

THE AUTHOR

KARL W. PETERSON worked for the General Chemical Co. after receiving his B. S. in Chemical Engineering from Penn State. However, he saw that his future was in instruments and soon became associated with the Bristol Company as sales engineer and application engineer. Since that time he has served 19 years in the sales or engineering end of the instrumentation field. He was sales manager for CDS Control Service before joining Manning, Maxwell & Moore, Inc., in 1954 as product manager.

In 1955, Mr. Peterson was named sales manager, Industrial Controls Division, when a separate division was formed to design, manufacture, and market the company's American-Microsen electronic process control system.

Cascade control systems can be established using completely standard components. The control signal from the primary controller is simply fed into the input of the secondary controller.

Ratio control is accomplished with a unit which retransmits some fraction or multiple of its input signal. In flow ratio control, for example, the primary flow transmitter feeds its signal to this ratio amplifier unit which retransmits its signal to reset the secondary controller. In this way, the flow controller is positioned to follow the variations of the primary flow transmitter according to a manually set ratio.

Economic Choice

Obviously the suppliers and users of electronic process controls are very conscious of cost comparisons with other systems. The user must generally justify his choice on the basis of the economics involved. The supplier cannot hope to create a market if the economics are out of line. Consequently, much work has been done in investigating costs.

Selling prices for electronic controls are now higher than for conventional, pneumatic systems. Installation costs are lower. The resulting installed costs—and the instruments aren't paid for until they're installed—is a figure that varies with the equipment and the type of installation. A blanket comparison cannot be made. However, a number of independent estimates has been made and showed that installation adds only between 15 and 20 per cent to the purchase cost of the electronic instruments.

Some economic factors to be considered in evaluating the two systems are:

1. Purchase cost of instruments (pneumatic will be less).
2. Purchase cost of completed panels (electronic should be less).
3. Purchase cost of communication lines—piping versus multiconductor cable. Piping may require troughs, etc. Wiring may require conduit, junction boxes, etc.
4. Purchase cost of accessory equipment—voltage regulators, etc., for electronics; air compressors, driers, filters, etc. for pneumatics. Although electronic controls now require an air supply system, the reduction in size and complexity should be taken into account.
5. Installation cost of panel and transmitters (should be about equal).
6. Installation cost of communication lines.

Advocates of electronic instruments add another very real, although unpredictable, factor in their favor—the possible reduction in check-out and

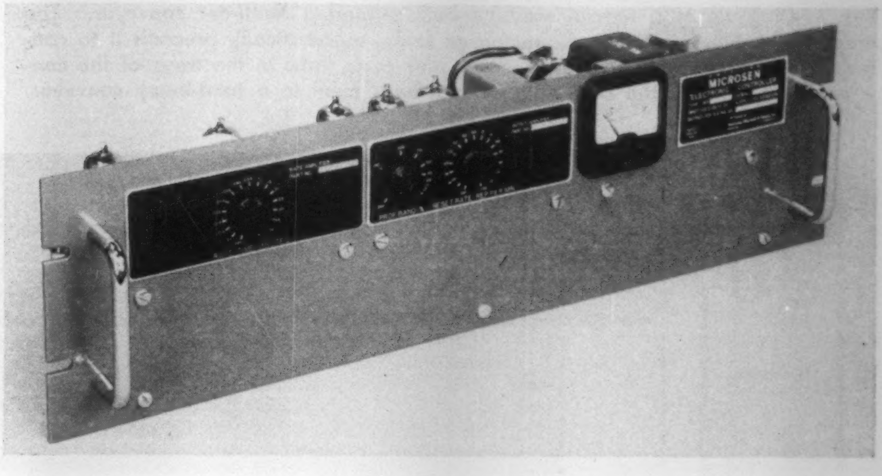


Fig. 5—Electronic controller showing manual settings for reset rate, proportional band and rate time. Vacuum tubes for this unit and other elements of the system are off-the-shelf components.

start-up time with electronic instruments. Also the American-Microsen System uses standard, off-the-shelf vacuum tubes, condensers and resistors which minimize the maintenance problem.

Suppliers of electronic instruments claim that a comparison only on the basis of initial cost doesn't tell the whole story. Such plus factors as improved process operation, greater convenience, and the possibility of modernizing existing installations as new data reduction systems come into common use are ignored. They also point out that electronic controllers were developed and are offered because of well-known limitations of existing systems. They feel quite certain that electronic controls will occupy an increasingly more prominent position in the process industries.

Multiple Flow Integrating System

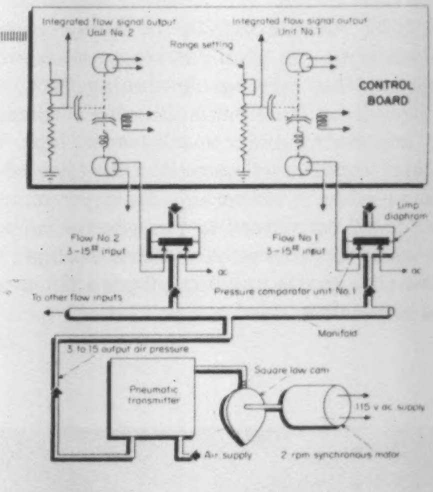
LOW-COST, highly versatile means for integrating and indicating the total flow of each of a number of process points has been developed by Fischer & Porter Co., Hatboro, Pa. The new multiple flow integrating system provides separate dial counter readings of as many as 20 total flow measurements on a single central station control panel. The system is unique in its use of a single, compact sensing and computing unit—a sweep pressure generator—to integrate flow of all points feeding into the system.

Incoming pressure signals—proportional to the flows to be integrated—are fed into individual pressure comparators. There is a separate comparator for each flow point. In the comparators, each signal pressure is balanced against the common sweep pressure. The resulting electrical output from each comparator advances a motor-driven dial counter by an increment proportional to total flow.

Use of separate counter panel and computing unit simplifies installation and permits flexibility of operation. Indicating panel—containing motor-driven dial counters for each flow point—can be placed conveniently in central station location. The sweep generator unit in turn can be installed to minimize runs of pneumatic tubing. Only electrical lines from each pressure comparator need be run into the control room.

Heart of the multiple flow integrating system is a synchronous motor driven, square law cam that causes a pressure transmitter to sweep from 3 to 15 pounds psig and back down to 3 psig. Motor is timed to produce two sweep cycles a minute. This control pressure is fed through a common manifold to one side of each of the opposed-diaphragm-type pressure comparators.

Each flow measurement, received as 3 to 15 psig pneumatic signal from a conventional differential pressure transmitter, is fed to the other side of its pressure comparator.



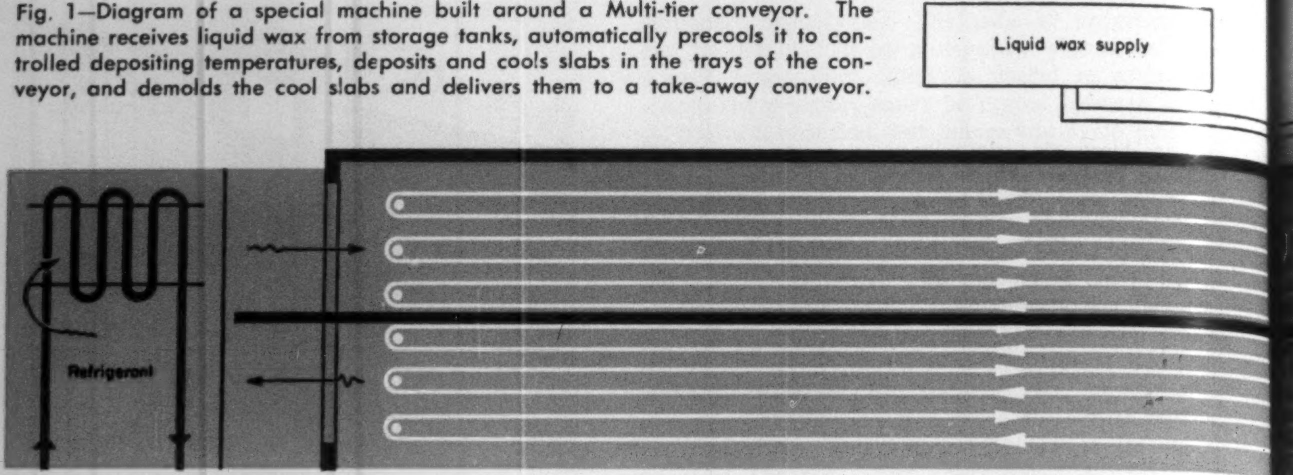
At the start of a cycle, the flow signal is always higher than the sweep pressure. Electrical contacts in the pressure comparator therefore are closed. This energizes the counter motor which in turn advances the dial counter.

The counter continues to advance until the sweep pressure builds up to a point where it equals the input signal pressure. The electrical contacts in the pressure comparator are opened. The dial counter stops.

The process is reversed in the second half of the sweep cycle. The counter does not advance until the sweep pressure drops below the flow pressure. The counter then continues to advance until the sweep pressure returns to 3 psig at the end of the cycle.

At the completion of each cycle, the dial counter has advanced an amount proportional to total flow during the period. Systems are available to provide either direct reading or arbitrary scale indication of total flow.

Fig. 1—Diagram of a special machine built around a Multi-tier conveyor. The machine receives liquid wax from storage tanks, automatically precools it to controlled depositing temperatures, deposits and cools slabs in the trays of the conveyor, and demolds the cool slabs and delivers them to a take-away conveyor.



TIERED CONVEYOR

CHANGES BATCH TO CONTINUOUS PRODUCTION

BATCH PROCESSING, in many cases, involves a simple physical action such as heating, cooling, drying, hardening, etc., for a certain period of time—this in effect consists of "storing" something under special conditions. Where the "special conditions" permit, this type of processing is peculiarly vulnerable to improvement by the addition of conveyors to provide for movement of work while in process. A modern example which illustrates this is the molding of paraffin wax into standard size cakes.

Despite an approximate 40 per cent increase in the use of wax over the past 15 years, the molding and cooling of wax cakes remained unchanged until the recent introduction of a completely automatic wax molding machine designed and manufactured by the J. W. Greer Co., Wilmington, Mass. Prior to this, wax slabbing was a batch operation requiring approximately 17 men for the production of 50 tons of wax cakes per day. Complex arrays of molds and cooling plates were assembled by hand and flooded with molten wax. Cold water

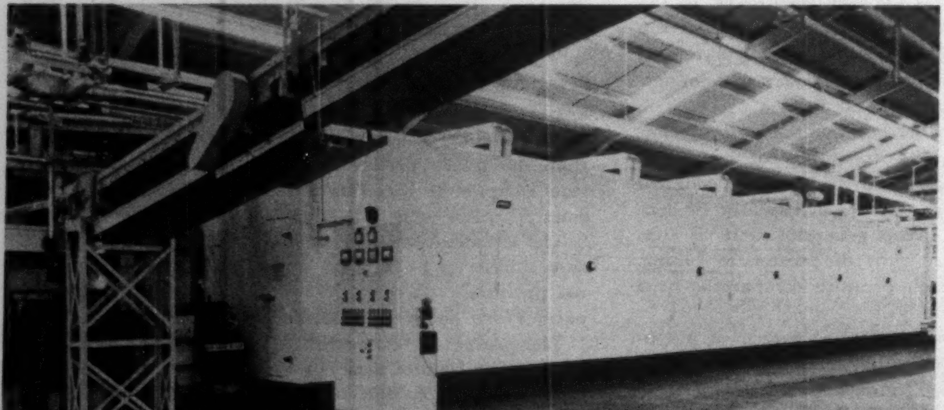
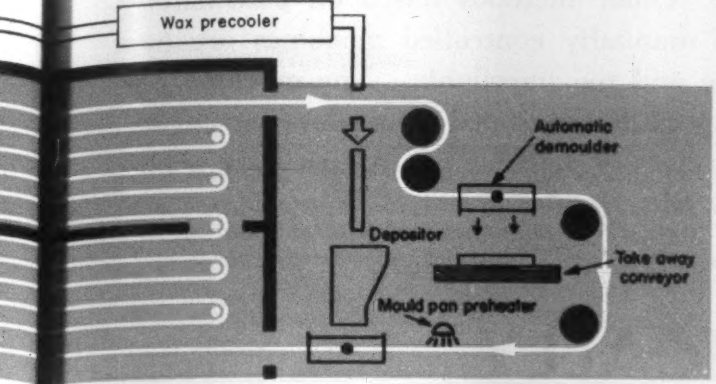


Fig. 2—Overall view of wax molder. The wax cake discharge conveyor in the foreground operates intermittently in delivering the finished slabs to a packaging machine or directly to a shipping point.



circulated through the plates hardened the wax; then each cake was laboriously pried loose and removed from the molds. Slow, inefficient production requiring large areas of floor space was the result. Other shortcomings of the batch method included uneven cakes and widely varying weights.

Molding the same quantity of wax per day in 25 per cent of the floor area with a labor saving of at least 85 per cent is possible with a multi-tier conveyor system. Quality control is also improved. Air holes common in manual batch molding are completely eliminated with the newer process. In addition, slab weights are held within ½ of 1 per cent for a given setting compared to variations of as much as 5 per cent with the old style batch method.

Basically, the wax molder, *Fig.* 1, consists of three sections: (1) Precooler to continuously deliver liquid wax at a preset molding temperature; (2) depositor head consisting of six cylinders and pistons for depositing wax into mold pans; (3) and the multi-tier cooling conveyor including an automatic demolding and unloading mechanism.

The wax molder packs up to 1044 feet of cooling travel in less than a length of 75 feet, *Fig.* 2. Its construction consists of a structural steel framework supporting pairs of parallel rails which comprise each tier. Running on these rails is a matched set of endless roller chains positively carrying the trays into which the wax is deposited. The tray stabilizing device shown in *Fig.* 3 insures that the solidifying wax is conveyed without jar or jolt even when moving from one tier to another.

Cooling time is variable according to the wax being processed. Cooling air circulation is laterally through upper tiers of the conveyor and back across lower tiers; then through the diffuser coils to be recooled and recirculated. After traveling through the cooling cycle, the solidified wax slabs are gently dropped onto an unloading conveyor by automatically inverting the mold pans and trays. Inverting of the trays is in exact timed relation to movement of an intermittently operated discharge conveyor which delivers the finished slabs to packaging or shipping point.

The multi-tier principle is ideally suited to any process requiring long in-process travel and gentle handling of the product. In addition to automated wax molding, these special conveyors are being used for other heating, drying, cooling and freezing processes, particularly in the food industry where the item being processed is relatively small in size. The compactness of the conveyor makes it practical to totally enclose the conveyor for all types of atmospheric conditioning. Freezing processes at subzero temperatures and pasteurizing and baking processes under high heat are performed with as great efficiency as those requiring more moderate temperatures. In addition, the enclosure can be separated into zones for controlled variations in the temperature or atmospheric conditions.

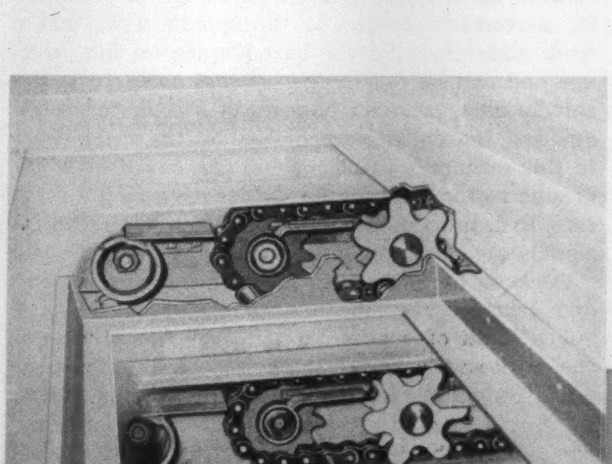
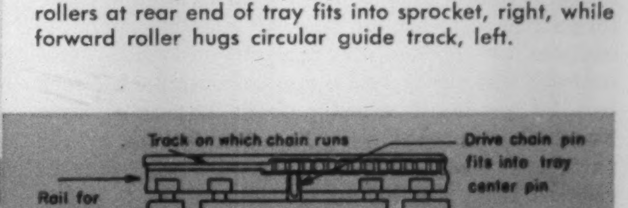
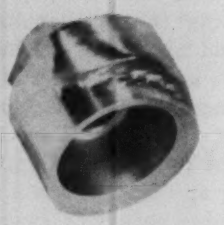


Fig. 3—Feature of Multi-tier conveyor is stabilizing mechanism which provides that trays will remain level and free from undesirable motion when moving from one tier to another. A conveying pin, projecting from the chain, fits into a socket on the tray midway between the rollers on which the tray normally moves. When moving vertically, up or down, one of these rollers at rear end of tray fits into sprocket, right, while forward roller hugs circular guide track, left.


Track on which chain runs
Drive chain pin fits into tray center pin
Rail for supporting tray and chain
Trays travel on bushed rollers at each corner

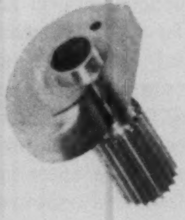


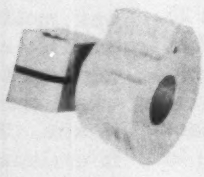
Improved methods to produce complex shapes such as three-dimensional cams are required for a growing volume of old and new products. Older methods based on painstaking manual effort and manually controlled machines are too slow, too expensive and too unreliable. The machine described here was specially developed to produce jet engine parts, but the techniques of machine control used are applicable to many other jobs.

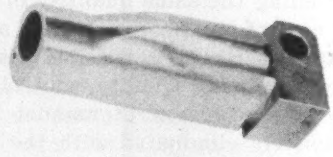
NUMERICALLY CONTROLLED MILLING

SHAPES THREE-DIMENSIONAL CAMS

By E. C. JOHNSON
Research Laboratories Div., Bendix Aviation Corp.
Detroit, Mich.







GENERATION of complex surfaces is required in the manufacture of an increasing number of production items. In older techniques of producing parts with such surfaces, master cams and engineering prototypes are laboriously produced and then copied by reproduction means such as tracer controlled machines. Three-dimensional cams for jet-engine fuel controls have been produced by those methods. Bendix Aviation Corp., however, has built a machine, *Fig.* 1, to automatically produce master cams and engineering prototypes directly from numerical control information recorded on punched plastic tape. No samples or models are required; finished cams uniformly accurate within approximately 0.001 inch can be produced directly from numerical data based on drawings or other descriptions of the part; and time to produce a master cam may be reduced from the 200 to 400-hour range to an 18 to 38-hour range.

The machine resembles a small lathe in basic configuration, except that a high-speed ball-end milling cutter is substituted for the lathe tool. As in a lathe, the workpiece is mounted so that it is rotated by a spindle; a tool carriage is arranged for movement parallel to the spindle axis; and a cross slide carrying the cutter rides on the carriage and can be moved toward and away from the spindle axis. As can be seen in *Fig.* 2, the carriage and the spindle are driven by the same shaft in this machine; and that shaft is driven by a hydraulic motor. The cross slide is driven by a separate hydraulic motor in accordance with control signals synchronized with spindle rotation.

Because of the fixed gearing between spindle and carriage movements, the cutter moves in a helical path of constant pitch over the surface of the work as illustrated in *Fig.* 3. The pitch of the helix, exaggerated in *Fig.* 3 for the sake of clarity, in practice is chosen to be consistent with the surface finish desired. Movement of the cross slide varies the radius of the helix as the carriage moves along the axis of the part, and an irregular contour can thus be formed. Since a helix of constant pitch is generated, the problem of generating the required three-dimensional cam surface

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Based on a paper presented at the National Industrial Electronics Conference, September 1955 in Detroit, Mich.

is reduced to a two-dimensional one—that of controlling radius of the helix as a function of angular rotation of the workpiece.

▸ Typical Workpieces

Pictures of workpieces shaped on this machine are shown opposite page. These cams are roughly cylindrical, but vary in radius along both axial and circumferential paths. In the application for which the cams are intended, control action is produced by a spherically shaped follower riding on the surface of the cam. Cam design procedures ordinarily aim at determining the locus of the center of the follower. This imaginary surface is usually defined in cylindrical co-ordinates by specifying its distance from an axis at uniform angular and axial intervals. Normal cam design procedures lead to the regular matrix illustrated in *Fig.* 3. Points are specified in parallel planes spaced widely compared to the pitch of the helical cutting path. A portion of the cutter-center helix is sketched on the cam schematic shown in *Fig.* 3. An interpolation and co-ordinate transformation therefore is required to determine points along the cutting path.

In normal operation of the cam machine, cutting is done by a ball-end milling cutter having a radius equal to the radius of the spherical follower to be used. The cutter center is then directed along the same path laid out for the follower center. If the radius of curvature of the path is at least as great as the cutter radius, the cam surface thus generated is such as to produce the desired motion of the follower. This practice is not impractical from metal-cutting considerations, and it avoids the need for complicated calculations to compensate for cutter and follower geometry.

▸ Preparation of Control Data

To produce a desired shape, the machine requires control information indicating the difference in radius, Δr in *Fig.* 3, between successive points along the helical tool path, and the angular interval, $\Delta\theta$, between those points. The process of data preparation begins with the manual key-punching of a card for each initially given point. This information is derived from an engineering drawing or table of dimensions. By interpolation the co-ordinates of points on the helical cutting path are calculated from the points given in the regular matrix. Once these points are recorded, the differences between successive points are taken, multiplied by a constant to convert to machine increments, and expressed in binary notation. These operations are carried out by routine procedures on standard punched-card accounting machines. Additional control information indicating sign of radius change, spindle direction, and an end-of-pass signal is punched into the cards and a parity-check digit is determined. This parity-check digit is used to make the total number of holes an even number in the com-

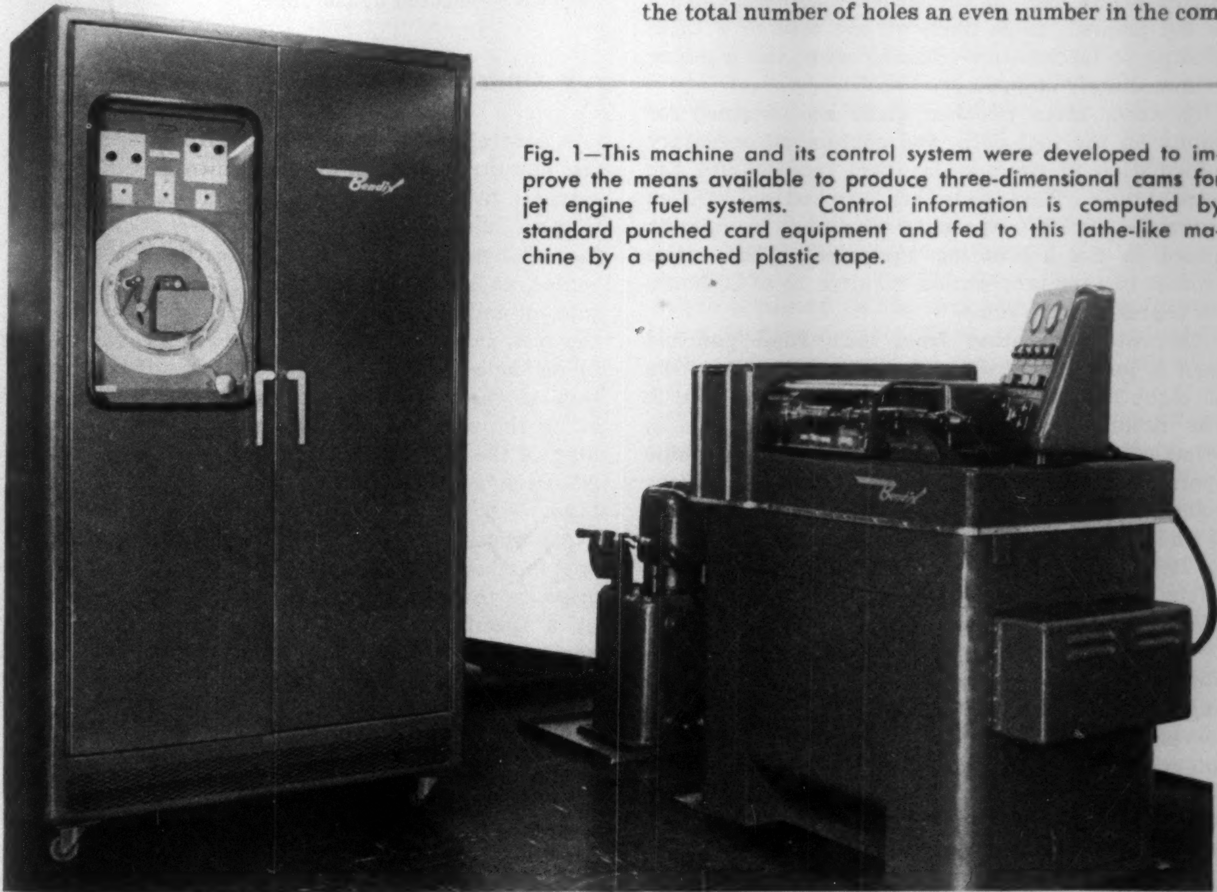


Fig. 1—This machine and its control system were developed to improve the means available to produce three-dimensional cams for jet engine fuel systems. Control information is computed by standard punched card equipment and fed to this lathe-like machine by a punched plastic tape.

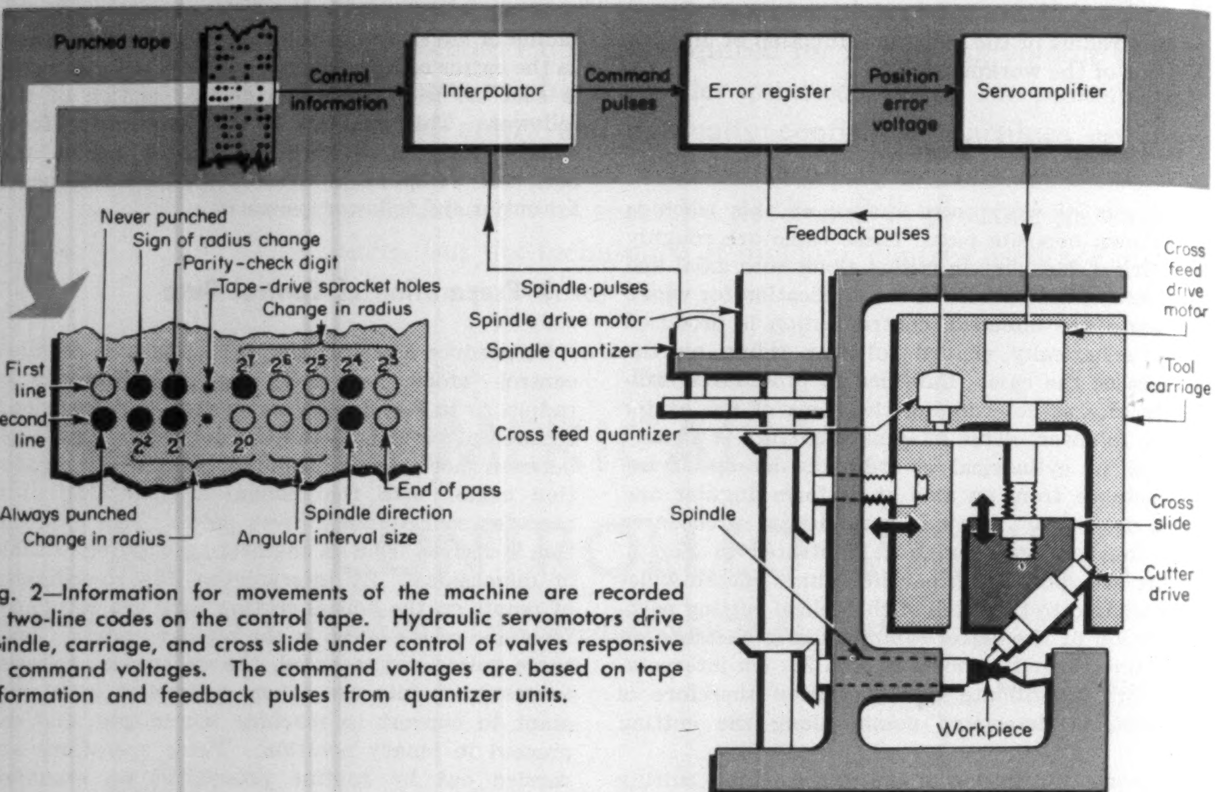

Punched tape
Control information
Interpolator
Command pulses
Error register
Position error voltage
Servoamplifier
Feedback pulses
Cross feed drive motor
Tool carriage
Spindle pulses
Spindle drive motor
Spindle quantizer
Cross feed quantizer
Spindle
Cross slide
Cutter drive
Workpiece
Never punched
Sign of radius change
Parity-check digit
Tape-drive sprocket holes
Change in radius
First line
Second line
2⁷ 2⁶ 2⁵ 2⁴ 2³
2² 2¹ 2⁰
End of pass
Always punched
Spindle direction
Change in radius
Angular interval size

Fig. 2—Information for movements of the machine are recorded in two-line codes on the control tape. Hydraulic servomotors drive spindle, carriage, and cross slide under control of valves responsive to command voltages. The command voltages are based on tape information and feedback pulses from quantizer units.

plete code specification punched in the control tape for each increment on the cam. Error-detecting circuitry built into the machine control system automatically examines the control information during active use. If the correct odd-even pattern is not present, as is likely in the case of a tape-reading or information-transfer error, the machine is immediately stopped.

By these steps punched cards are obtained for points on the tool path, and contain all necessary information in exactly the form required for the control tape. The tape is then punched and verified automatically by specially designed equipment linked to the accounting equipment. The entire process of tape preparation requires 15 to 30 hours for representative cams.

Control information from each final punched card is punched into the control tape in two rows of eight hole positions each, as shown in *Fig.* 2. The radius difference is entered on the tape in terms of the basic increments in which the machine operates. These are fixed by gearing in the present machine to 0.0002 inch. For example, an increase in radius of 0.03 inch corresponds to 150 increments, or 10010110 in binary notation. Holes are punched in the tape for "ones" and not punched for "zeros". The resulting pattern is shown in *Fig.* 2.

Two hole positions, providing four possible combinations of holes or no holes, are used to specify angular interval. In the present machine, the intervals can be 5, 10, 20, or 80 degrees. The larger intervals may be used to reduce the amount of control data required when contour changes are relatively mild. A separate spindle speed is provided for each size of angular interval. The speeds are set by manually adjustable potentiometers, but become effective only when the associated angular interval is selected by the tape.

▶ Controlled Cutting Operation

A control tape, together with automatic sequencing circuitry included in the controls, guides the machine through the complete cam milling process. Control tape for the machine is wound around a large hollow reel, with the tape reader placed in the center, as may be seen in *Fig.* 4. The tape, spliced into an endless loop, is pulled out of the center of the reel, passes through the tape reader, and winds up on the outside of the reel. One complete circulation of the tape corresponds to a complete pass along the axis of the cam and back to the beginning of the contour. The return trip may be a fast return or a second cutting pass, as specified by the tape.

A programming panel, *Fig.* 5, provides for making any number of passes up to 50, automatically decreasing the overall contour radius between passes by a specified amount. The required number of passes is set by the dials on the right side of the panel. A pass counter just below them indicates the number of the pass in progress at any time. The desired depth of cut between passes is set by the dials on the left side of the panel. The coarse cut, 0 to 100 mils (0.100 inch), is taken on every pass except the last, and the fine cut, 0 to 10 mils, on the last. After the last pass has been completed, the machine returns to the initial starting point, requiring only that a fresh blank be loaded and the *Start* button pressed to repeat the process.

▸ Control System

A primary function of the machine control system is to guide the tool when it is cutting between known points along the helix. This function is performed in such a way as to connect the known points with arcs of a spiral—essentially a linear interpolation of radius with angle. Because of this built-in interpolation feature, the machine requires only a relatively small amount of input data compared to that which would be needed to generate the surface by specifying a sufficient number of separate cutter positions.

Control information specifying the amount by which the cutter position is to be changed during each angular interval is read from the tape into the interpolating circuitry. Also supplied to the interpolator is information locating the angular position of the spindle. The spindle information originates from a quantizing device connected by precision gearing to the spindle drive motor. It functions in effect as a pulse generator, producing 256 electrical pulses for each 5 degrees of cam rotation, or approximately 50 pulses per degree.

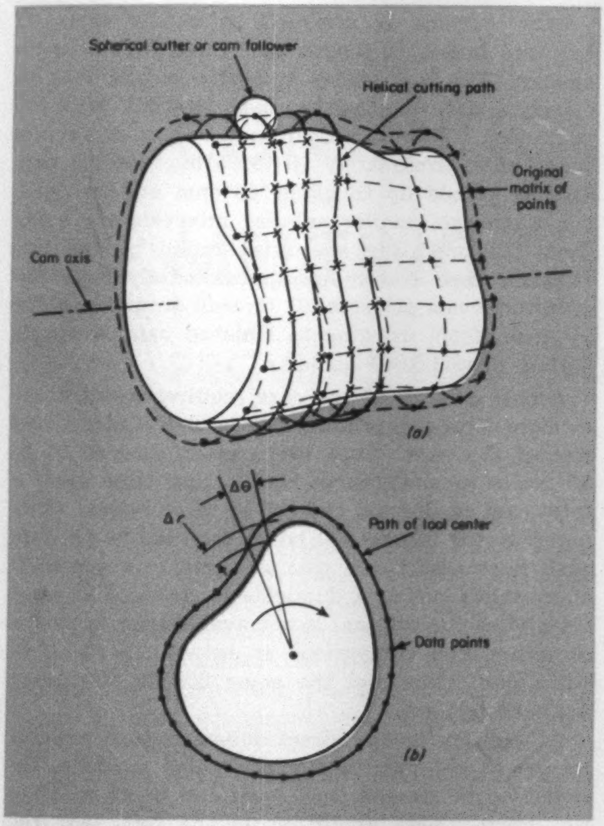
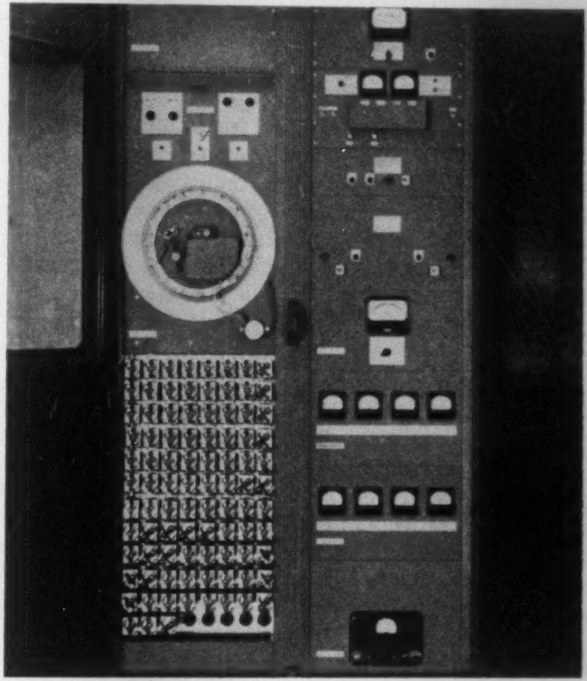


Fig. 3—Typical cams are generated on the machine by use of a spherical cutter equal in diameter to the follower which will be used. The centerline of cutter or follower travel is generally specified as a matrix of points in planes perpendicular to the cam axis as shown in (a). Although the cutter path is helical, the pitch of the helix is kept constant, so that cutter motions can be specified in terms of change of radius and change of rotational position from an original position as illustrated in cross-sectional view (b).

Fig. 4—Controls for the machine are mounted in this separate cabinet. The endless control tape is pulled out of the center of a hollow reel, read, and wound on the outside of the reel.



As spindle pulses are produced, the interpolator selects certain ones to be used as cross-slide command pulses. Each command pulse represents a desired cross-slide motion, and consequently cutter motion, of 0.0002 inch. If, for example, a rise of 0.03 inch is required in 5 degrees, 150 command pulses would be selected from the 256 spindle pulses produced as the cam blank rotates through the 5-degree interval. These 150 pulses, at 0.0002 inch each, represent the desired cutter travel of 0.03 inch.

The interpolator consists of a binary operational multiplier and two flip-flop storage registers, one a temporary storage register and the other an active register. As cutting proceeds through each angular interval under control of the active storage register, information for the succeeding interval is read into the temporary storage register. When the boundary between intervals is crossed, the new information is transferred to the active storage register, and the tape reader begins to read information for the following interval. This use of two registers, with practically instantaneous transfer from one to the other, allows continuous operation of the machine from one interval to the next.

Controlled by the difference information in active storage, the multiplier consists of a binary counter and is fed pulses from the spindle quantizer, with appropriate gating to channel certain of the pulses to the command-pulse line. Pulses produced by the counter stage nth from last ($n = 0$ for the last stage) are passed if the coefficient of 2^n in the binary-coded difference is one. The pulses thus gathered form the command pulse train. Operation of the circuit is such that the output command pulses are distributed approximately uniformly with respect to the input spindle pulses, defining a smooth curve between data points. Overflow from the counter indicates the end of an interval. Information is then transferred from temporary storage to active storage, and the tape reader advances to the next block of information. This system is logically similar to that employed in the numerically controlled machine developed at M.I.T.

Cross-slide positioning is carried out by a high-performance servomechanism in response to command pulses generated by the interpolator. Feedback is provided by a quantizer similar to that associated with the spindle. The quantizer produces a pulse for each 0.0002 inch of slide motion. Such a pulse then represents actual motion in the same terms that a command pulse represents desired motion.

A reversible binary counter performs the error-sensing function in the servo loop by counting continuously both command and feedback pulses. Command pulses are counted in one sense and feedback pulses in the other. At any time the counter therefore holds the difference between the number of command pulses generated by the interpolator and the number of feedback pulses received from the cross-slide quantizer. This net count is converted to a proportional voltage by a resistor-rectifier decoding matrix and furnished as error voltage to the servo amplifier. The amplifier operates a specially designed valve which meters fluid to the piston-type rotary hydraulic motor driving the cross slide.

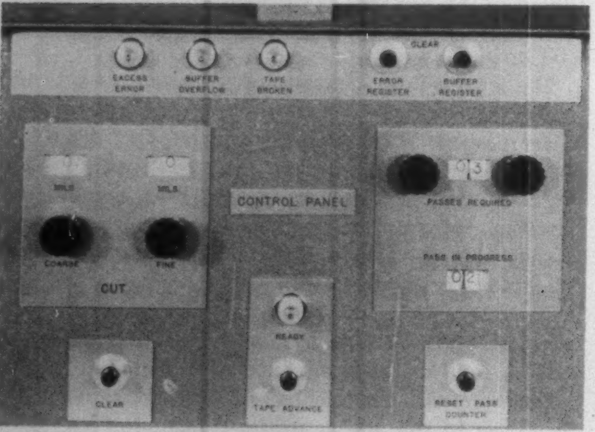


Fig. 5—This control panel is mounted above the tape unit in the control cabinet. Depth of cut per pass and number of passes along the axis of the workpiece are manually set at this panel.

Careful attention was given to inertia, structural rigidity, friction, and backlash in the machine design. This early recognition of the potential mechanical problems, coupled with the performance characteristics of the hydraulic components and appropriate dynamic compensation of the servo loop, has resulted in a fast acting cross-slide servo. Its velocity constant is about 1500 per second and bandwidth well over 100 cps. The slide therefore is able to follow rapid variations in cam radius with small dynamic error. While cutting a typical contour under normal operating conditions, the average dynamic error ranges from ½ to 1½ times the 0.0002 inch increments.

Most of the electronic circuitry is built up from a relatively small number of different types of one or two-tube plug-in units. Although operation of the machine control system was described in terms of pulses, direct-coupled clock-gated circuitry is used throughout. The complete system contains about 165 vacuum tubes and about 1200 germanium diodes.

▶ General Points

This machine is designed to handle cams up to three inches in length and three inches in diameter. The ball cutter typically is 0.25 inch in diameter and longitudinal feed is 0.005 inch per revolution. This combination produces a surface finish of approximately 15 to 25 microinches rms. Spindle speeds up to about 40 rpm are provided, but when the smaller angular intervals are being used, the operating speed is limited by the mechanical tape reader to approximately four angular intervals per second. Overall accuracy of the machine, from drawing to finished cam, averages within about 0.001 inch.

Actual cutting of the cam requires about three to eight hours, depending on the depth of cut and size of the cam. Tape preparation time of 15 to 30 hours in addition to the cutting time gives a total cam production time of 18 to 38 hours. Compared to the 200 to 400 hours required to produce such a cam by hand, this amounts to a considerable saving, and if a duplicate is required at some time when the original is not available or in usable condition, the comparison is between a three to eight hour time and the same 200 to 400 hours for hand methods.

In addition to the direct dollar savings possible by use of the numerically controlled machine, the reduction in elapsed time itself can be of substantial value. Also important is the fact that the machine produces a much more uniform and predictable product than is possible when hand techniques are involved. The entire contour in a sense is mathematically defined, rather than subject to the esthetic sense of an individual who hand-fairs the surface between specified points. As a final benefit, the machine can be applied equally well in principle to cams of other types within its capacity or to turbine and compressor blades.

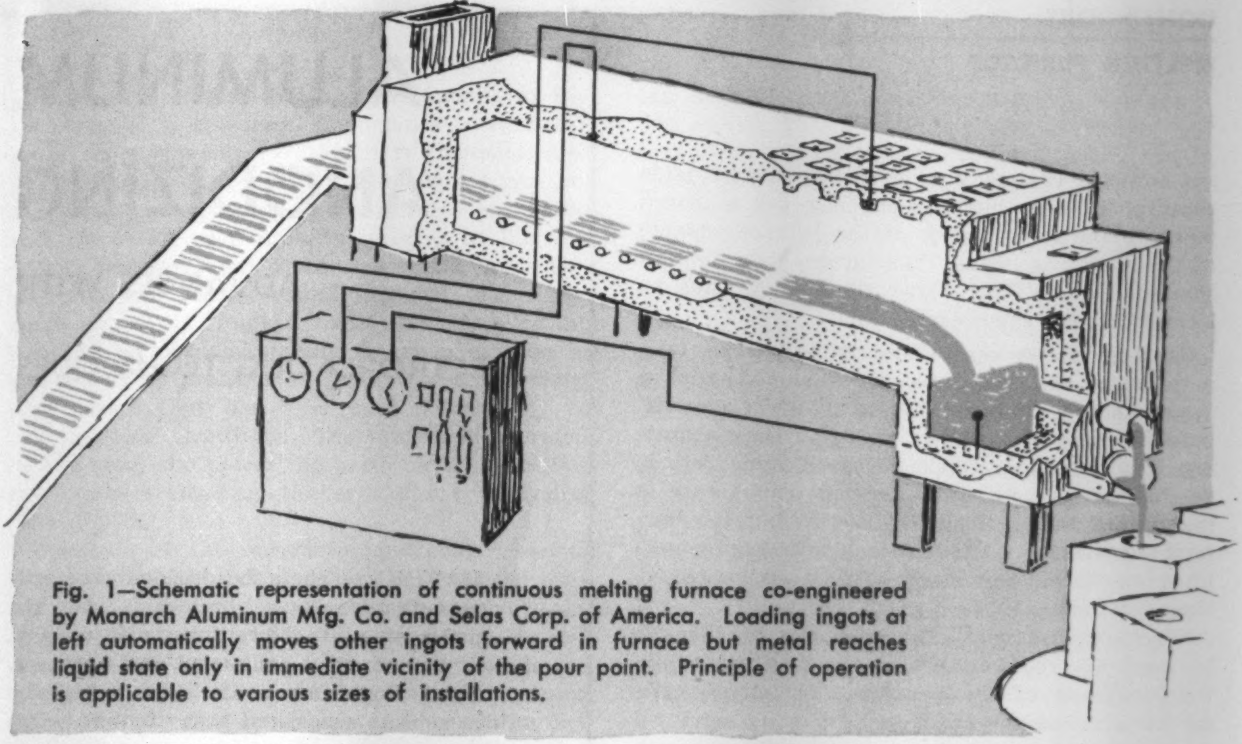


Fig. 1—Schematic representation of continuous melting furnace co-engineered by Monarch Aluminum Mfg. Co. and Selas Corp. of America. Loading ingots at left automatically moves other ingots forward in furnace but metal reaches liquid state only in immediate vicinity of the pour point. Principle of operation is applicable to various sizes of installations.

CONTINUOUS MELTING FURNACE

PROVIDES FOR PRODUCTION FLEXIBILITY

CONTINUOUS melting of aluminum alloys for casting has resulted in superior working conditions, reduced foundry overhead and a closer control on metal handling and casting quality for Monarch Aluminum Mfg. Co., Cleveland, Ohio. A substantial saving in fuel cost is realized by eliminating the wasteful heating of heavy furnace equipment and large reserves of molten aluminum.

The new melting method is based upon a radiant gas fired tunnel furnace engineered jointly with the Selas Corp. of America. In its original conception, a relatively small tunnel furnace slopes downward (about 2 inches per foot) from the input to the output end. Ingots are loaded at the upper end, and automatically pushed lengthwise under a furnace roof containing Selas Duradiant burners. The melting rate and the pouring temperature are controlled by regulating the speed of the ingots through the furnace and the fuel input to the burners. The molten aluminum flows continuously through an opening near the lower end of the furnace, directly into a pouring ladle. The cycle from cold ingot to liquid metal takes 24 to 30 minutes. If the direct pour principle is not desirable from a production standpoint, alternate designs embodying a limited holding pot principle are readily adaptable.

Heat transfer occurs between the incandescent burner cup located in the roof of the furnace and the aluminum charge largely by radiation, bringing the aluminum quickly to the melting point. Sixty burners in four rows of fifteen, are patterned to provide a radiant roof 10 feet long and 3 feet wide over the final 1/3 of ingot travel within the furnace. Combustion products provide preheat during the first 2/3 of ingot travel, and offer some atmosphere control.

The design of the furnace is such that there is no aluminum in a fully liquid state except in the immediate vicinity of the pour point. Thus there is little chance for the formation of oxides. Each ingot however, is already covered with a normal oxide coating. This coating does not melt, but is moved down to the lowest point of the furnace, outside of the operating region. The furnace operator can remove the collected oxide films from time to time, whenever convenient.

Start-up charge can be brought to pouring temperature in less than three hours, as compared to approximately 22 hours needed in a conventional batch furnace of a similar capacity. Once operating temperature is reached, the charging rate is set to meet the demand. Pouring temperature is maintained automatically by controlling the burners in response to a thermocouple sensing temperature in the ladle or small holding pot located at the output end.

When one run ends, the alloy can be changed to meet the requirements of the next run while the furnace is still in operation. This simply calls for anticipating the change, and loading ingots to meet the new specifications in time for them to reach the pouring stage as different molds are placed in service.

In addition to the actual immediate reduction in costs, continuous melting provides a much closer control of these costs. In effect the direct cost of melting aluminum becomes very nearly proportional to the weight melted. Therefore, small furnaces for low production rates become practical, and it is relatively economical to start up a furnace even for a short run. Part of the economy and flexibility of continuous melting lies in the small quantity of aluminum in process. As an example, consider a 2000-pound-per-hour pouring rate. In the continuous melting furnace, only 1000 pounds of aluminum are being processed at any one time, with only a few hundred pounds of it actually in the molten condition. To meet the same production with conventional reverberatory furnaces about 15,000 pounds of aluminum must be held in a liquid state at all times. The new type furnace can be shut down in a matter of minutes with only a few pounds of metal to pour off and a minimum of oxides to remove. The furnace can be restarted and up to pouring temperature in less than an hour under many circumstances when a production delay occurs.

In their permanent mold casting room, Monarch is now using three continuous melting furnaces with capacities of 1500, 1800, and 2400 pounds per hour, at a rated 1400F pouring temperature. They have been operated at rated capacity, and at as little as 60 per cent of capacity without any appreciable decrease in efficiency. But perhaps most importantly, Monarch has turned up no evidence that would indicate any limit to building similar furnaces in much smaller or much larger capacities.

ALUMINUM ANODIZING

ADVANCES WITH ELECTROPLATING TECHNIQUES

HAVING reached the decision that self-manufacture was preferable to the purchasing of chairs for resale as part of their line of office equipment and furniture, Art Metal Construction Co. next faced the various aspects associated with "how to." One step in processing, anodizing the aluminum parts, figured as a major problem.

An aluminum anodizing system involves successive movement of parts between an alkali cleaning, sulfuric acid etching, hot water sealing, and several spray rinsing operations. Such a system assumes the aspects of a special

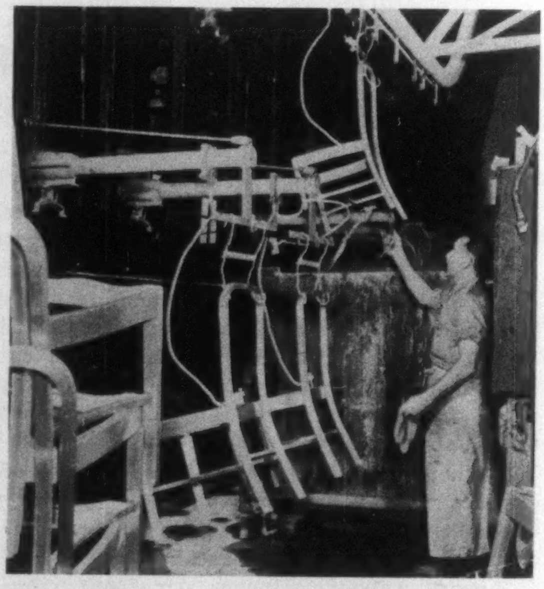


Fig. 1—Parts to be anodized are manually loaded onto a carrier arm of the conveyor. The conveyor is equipped with separate drives for forward movement and elevator lift. A 48-inch vertical movement of the carrier on the elevator insures total immersion of parts in tanks.

problem to Art Metal because: Uniformity of finish obtained is of special importance to furniture items; as a manual operation it is an undesirable and relatively dangerous job; and space requirements for a sizable manual installation are excessive. In short, as a problem, production line anodizing involves some of the major factors which automation is ideally suited to solve. The automatic conveyor designed, built and installed by Hanson-Van Winkle-Munning Co. as a solution to this anodizing problem, is of the elevator, return type design that has been used successfully in electroplating operations. The system is operated by one man who places the parts on the conveyor and removes them at the end of the anodizing cycle, *Fig.* 1.

Elements of the automatic anodizing installation consist of a special conveyor, a remote control panel, a motor generator set and seven tanks of varying sizes that hold the rinsing bath and anodizing solutions.

In more detail, the conveyor employs separate drives for forward movement and elevator lift to move the material through the system and raise and lower it at the various tanks, *Fig.* 2. Timing mechanisms insure identical immersion periods for each part at the various steps.

The conveyor has 44 carriers, each capable of holding a maximum of 30 lb of parts. The carriers have been designed such that each carrier can handle several parts where weight and space will permit, *Fig.* 3. For example, one carrier can hold one assembled chair, or four swivel chair bases, or six backs of arm-type leg chairs, etc. The system will process a total anodized area of around 670 square feet per hour.

The complete operation of the system from start to finish is automatic, with the exception of the load and unload operation. Cooling and heating units with temperature controls insure the maintenance of proper temperatures throughout the seven tanks in the system. Control of the system is maintained by the operator at the control board located at the loading station. This control panel is provided with *Stop* and *Start* buttons, *On* and *Off* lights, starting controls for the forward and vertical conveying motors, and a cam operated electrical timer that controls start and stop motions. Cutouts for electric switches and an electrical timer for varying immersion time are also provided.

In addition to maintenance and operating economies and higher production rates achieved with an automatic anodizing system, it is of interest to note that Art Metal uses the special anodizing treatment as a selling point with prospective customers. The company stresses the uniform surface protection resulting from automatic anodizing—a result of stability of processing that could not be guaranteed in a manual system.

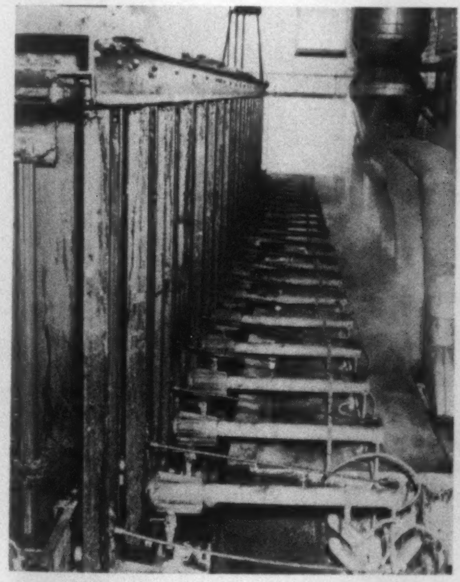


Fig. 2—General view of the acid bath in the anodizing system. Entire anodizing cycle takes approximately 80 minutes, of which material is immersed in this sulfuric acid electrolyte bath for 30 minutes.

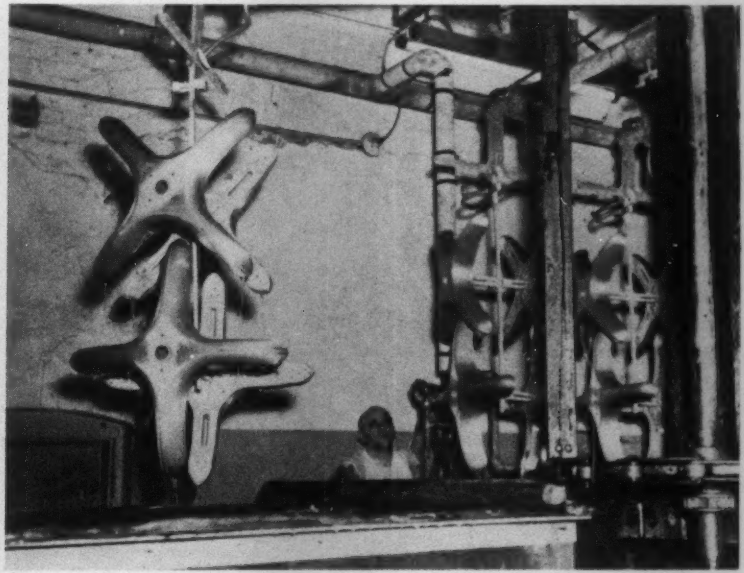


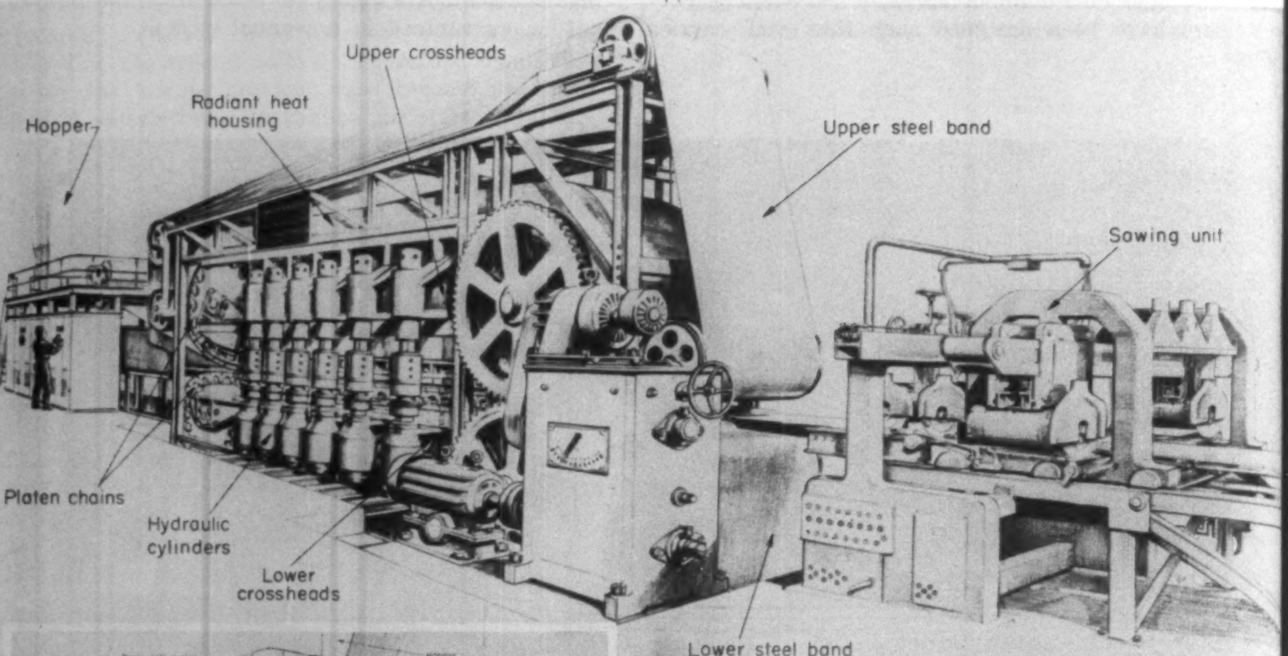
Fig. 3—Each of 44 carriers is designed to hold a maximum of 30 lb of chair parts. Here, four swivel chair bases are being processed. Standard processing of all parts by automatic system insures the necessary uniformity of appearance so important to furniture items.

CONTINUOUS PRESS AUTOMATES FIBERBOARD MANUFACTURE

Demand for practical, stable, and low priced fiberboard plus the diminishing reservoirs of exploitable timber have led to the increased use of waste products in fiberboard manufacture. Considering the economics of the situation, only one solution to the manufacture of fiberboard appeared feasible to a British firm—they must develop a continuous production process involving a fully automatic press.

By LEO WALTER
Consulting Engineer
Cheltenham, Glos.
England

APPROXIMATELY 60 per cent total waste normally occurs when standing timber is converted into lumber. The widespread availability of a potentially useful waste product and a general knowledge of the principles of reconstituting this type of material into a usable product has through the years led to the development of various batch-type processes for production of fiberboard. However, to the British Artificial Resin Co., the


Upper crossheads
Radiant heat housing
Hopper
Upper steel band
Sawing unit
Platen chains
Hydraulic cylinders
Lower crossheads
Lower steel band

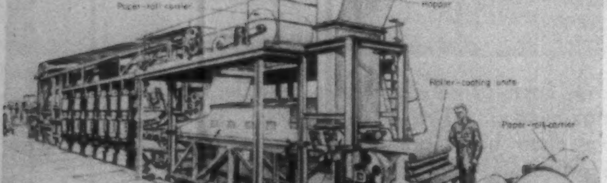

Paper-roll carrier
Hopper
Roller-coating units
Paper-roll carrier
Radio-frequency oven
Feeder

Fig. 1—Ground wood particles, mixed with resin, are continuously fed from feeding unit through high-frequency heating oven prior to compression. Carpet of material then enters continuous press formed by two endless steel bands. Pressure and curing heat are applied to continuously moving product through radiant-heated platens. Completely cured board product is edge-trimmed and cut into desired lengths at saw unit.

limitations of the batch-type process when compared to the increased demand for building materials following the recent wars re-emphasized the importance of completing a project initiated in 1939—the development of a continuous production process involving a fully automatic machine for the production of fiber board. Marking a successful conclusion to the project, the first full-size commercial plant utilizing the Bartrev continuous process was placed in operation at the factory of deVere Engr. Co. Ltd., over three years ago. Operating at full capacity, a 134-ft long continuous automatic press, *Fig.* 1, in this initial plant has an annual output of 16,000 tons of processed board, or between 25 and 40 million square feet, according to the thickness of the board produced.

▶ Automation Viewpoint

The Bartrev process is designed to produce high quality board from a wide range of fibrous materials, the most commonly available being timber that would otherwise go to waste—the "cuttings, tops and branches" that the lumber industry cannot use, and wood "waste" from sawmills and factories. The choice of raw materials to be used depends on the location of the plant. Board can be made just as effectively with hard wood as with soft wood, though the character of the end product will naturally vary.

From the viewpoint of automation, the Bartrev plant has been designed to take into full account all physical, chemical and engineering aspects of board manufacture, and in order to meet various raw material conditions, variations of the continuous flow process have been developed.

Conventional methods of making board from wood and thermosetting resin use a multiplaten press, which holds the boards under pressure and heat in order to produce polymerizing of the resin. Mechanical handling, heating and application of pressure of each batch is cumbersome and takes a long time, without ensuring uniformity of the product.

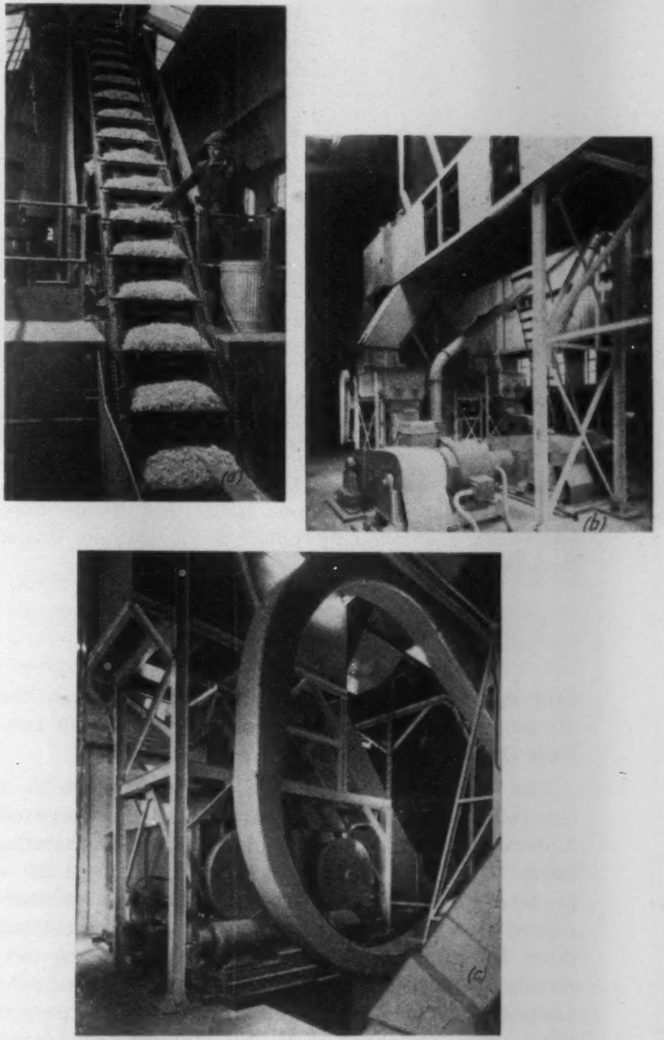


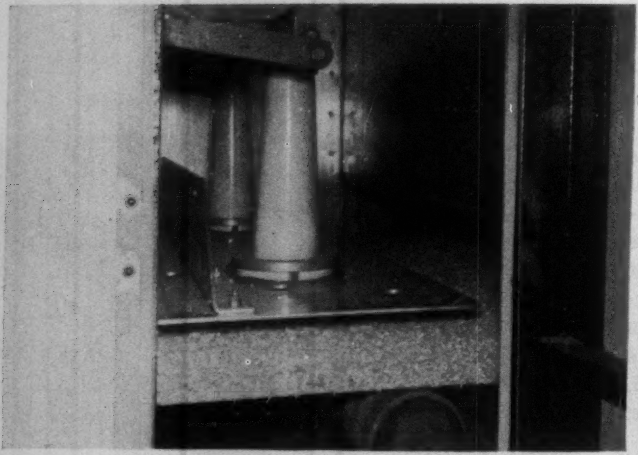
Fig. 2—Raw material is conveyed from storage (a) to grinding mills (b) for reduction to uniform size. If necessary, moisture content is reduced in recirculating pneumatic dryer. Particles are coated with resin in vats behind recirculating loop of pneumatic dryer shown in (c).

▶ Material Preparation

The aim of the Bartrev design was to produce board in an uninterrupted flow with as little human operation as possible. This target was achieved by: (1) Mechanical mixing and loading, (2) automatic continuous filling of rollers under pressure, (3) conveyor drying of a continuous sheet under controlled heat, and (4) mechanical cutting and unloading.

The main principles of preparing wood waste for reconstruction into useful board are generally known and several types of existing plant equipment can be used, including conventional shavers and hammer mills. The first stage is to reduce the raw material to uniform and correct particle size. The second stage, vital to the process, but also generally known in the industry, is to control the humidity. The compressibility of wood depends on the moisture content, but this varies greatly from wood to wood and from load to load. Drying units incorporated in the raw material preparation plant reduce the humidity content to a predetermined and uniform level.

The Bartrev factory has been designed particularly to handle raw material in the form of soft wood shavings. It includes for the raw material preparation an elevator for carrying shavings to the grinding mill where grinders reduce the shavings to the right particle size. The grinding mills incorporate fans for automatic transport to a cyclone. From here the material flows by means of a pneumatic system to a vibratory screen which separates the undersized particles. The graded material is fed into a storage bin provided with means to break any arches which form. For cer-



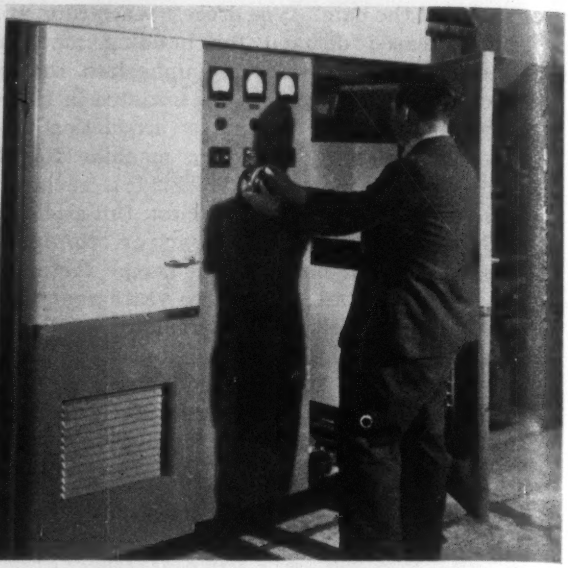


Fig. 3—Initial temperature treatment, by means of high-frequency heaters, prepares wood for compression. Electrodes are manually adjusted for varying carpet thicknesses.

tain materials the ground particles flow from the air-swept mills into a pneumatic drier which controls the moisture content, *Fig.* 2.

The raw material storage bin is fitted with a controlled discharger, which releases the prepared material to the specially designed resin mixing units. The raw materials enter the mixer at a predetermined and controllable rate in uninterrupted flow. At the same time liquid thermosetting resin is added and sprayed into the moving materials. The pH value of the liquid is automatically controlled before the resinated material is passed through to the hopper at the loading end of the continuous press. Because of the short curing cycle of the Bartrev process, special quick setting resins must be used and the types of resin and hardener most suitable for the process have been the subject of extensive research. The proportion of resin to raw materials varies from 5 to 8 per cent according to the types of wood used and the properties required in the end product. The resinated material is then passed through a hopper to the press.

Press Operations

The continuous press is an assembly of four essential parts: (1) A feeding unit, (2) a high frequency heating unit, (3) the press itself, and (4) an automatic saw. The whole unit is compact in layout and, considering its very large production capacity, small in size.

The feeding unit comprises an automatically loaded hopper equipped with photoelectric means to control level; a gravity chute; and an automatic feeder to lay the carpet of raw material to any required uniform thickness on an endless steel belt. The heating unit comprises high frequency heaters with a total output of 90 kw providing an extending field through which the raw material carpet is conveyed at about 20 fpm, *Fig.* 3. Moisture and temperature control are closely interlinked throughout the entire process. Temperature has a great effect on the compressibility of the raw material. Research indicated the need for preheating the wood resin mixture before the power consuming step of compression. The high frequency heaters raise the temperature to between 80 and 90C. The length of time that the carpet of

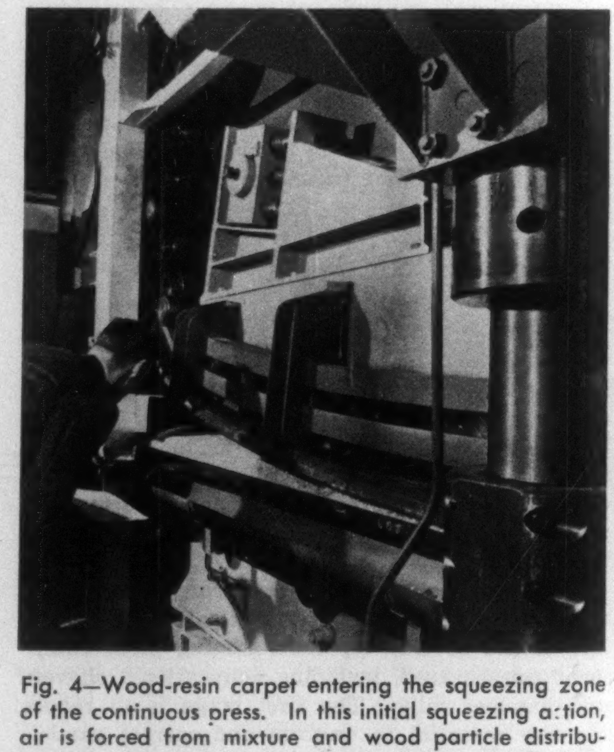


Fig. 4—Wood-resin carpet entering the squeezing zone of the continuous press. In this initial squeezing action, air is forced from mixture and wood particle distribution is rearranged prior to curing pressure application.

raw material remains in this preheating field is insufficient to allow harmful evaporation of moisture or precuring of the resin which is effected during the next step under pressure.

The continuous press comprises two endless heated platen chains and two endless polished stainless steel bands face to face, the one above the other. The raw material carpet is carried on the lower steel band through the H.F. heating field to the press.

▸ Mechanical Operations

The patented features of this part of the process include the design and motion of the platen chains so that their edges cannot damage the steel bands, and the even distribution of pressure when the wood-resin carpet enters the press. The compacting process consists of two stages, the first, *Fig.* 4, being the expulsion of air from the voids and the re-arrangement of the wood particles to fill the voids; the second being the actual compression of the particles. Of these stages the last, *Fig.* 5, requires considerable pressure, but after it has been completed and curing of the resin has started, only relatively little pressure is required for holding the board at its correct thickness to prevent recovery.

The final heating stage in the press is by heat transfer from the radiant-heated platens which raises the temperature of the raw material to the 110 to 115C range according to the type of board to be produced. This temperature is maintained by thermostatic control until the raw material leaves the pressure zone as fully cured and compressed board.

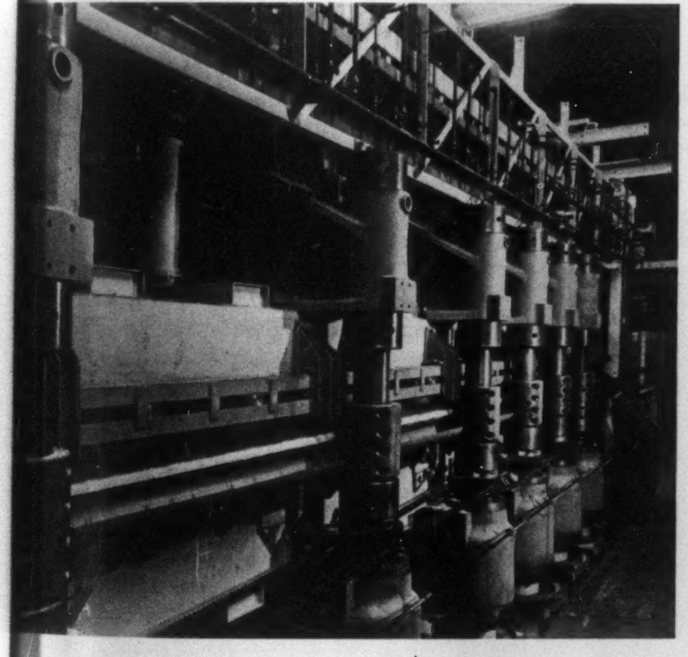


Fig. 5—Hydraulic cylinders provide desired pressure through longitudinal steel rails and roller bearings to platens in contact with stainless steel bands. This picture shows the pressure zone of the press.

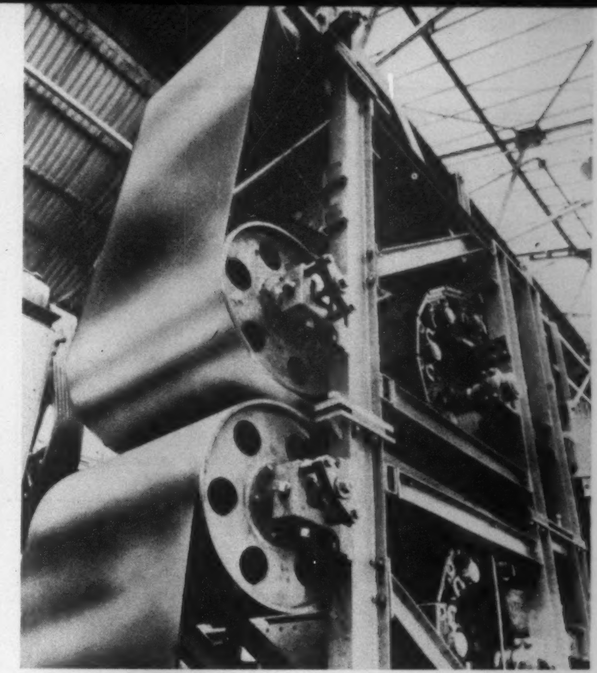


Fig. 6—Output end of press. Automatic adjustment of drums is provided to insure proper tension and parallel movement of the steel bands.

The polished steel bands are carried on steel drums, four to each band, *Fig.* 6. Tension is applied to the bands and automatic adjustment to the drums is provided to ensure true parallel movement. Provision is also made to ensure that contraction of the bands on cooling does not introduce any risk of overstressing either the bands or the drums. The entire press is driven by an electric motor operating through a gear box permitting speeds between 5 and 30 fpm. This is one of the factors which gives the Bartrev process great versatility, since speeds can be controlled to correspond with varying raw materials, resin contents, thicknesses and densities. Devices for carrying rolls of paper and applying the paper to one or both sides of the board are incorporated in the press. The paper is coated with resin and fed onto the steel bands prior to laying the wood-resin carpet.

▸ Design Details

The design of this ingenious continuous press presented many problems. Just to mention one detail, friction of the cylindrical drums supporting the upper and lower platen chains had to be kept to a minimum. To achieve this, 1580 spherical roller bearings of special design were used for supporting 78 platens in the upper and 80 in the lower chain. Each platen is 50 inches wide and 12 inches long. A series of hydraulic cylinders provide pressure to longitudinal steel rails, and rollers transfer this pressure to the material. The

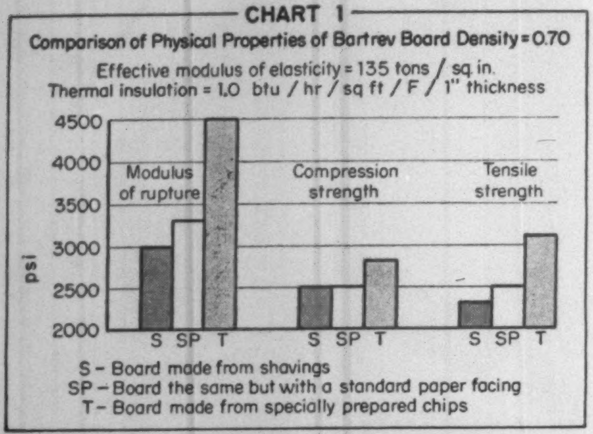


CHART 1

Comparison of Physical Properties of Bartrev Board Density = 0.70

Effective modulus of elasticity = 135 tons / sq. in.
Thermal insulation = 1.0 btu / hr / sq ft / F / 1" thickness

maximum nip pressure between the platen chains is 500 psi, staggered in two stages. During the first 10 feet of travel the pressure is built up, and then held for over 16 ft, at between 10 to 30 fpm platen speed. The rollers are fitted to the pressure platens and are in contact with the working faces of the pressure rails, *Fig.* 7. Self-aligning ball bearings of the spherical type proved the ultimate solution under the encountered heavy loading and restricted space.

At the delivery end of the press automatic saws are fitted to perform two operations: First, the edges of the board are automatically trimmed as it emerges from the press, and secondly, a saw operating in a transverse direction square cuts the moving board to any required length, *Fig.* 8.

CHART 1 gives data on physical properties of Bartrev board, made from wood shavings of standard quality. It also gives data on board with standard paper facing, and for board made from specially prepared wood chips.

The continuous production process has resulted in board which differs in several respects from similar batch produced products. It has only one fixed dimension—the maximum width of 4 feet which is governed by the width of the press. Because it is made on a continuous basis, it can be supplied in any required length and because the distance between the press platens is adjustable, it can be made in any thicknesses from 3/16 to ¾-inch. With the elimination of the human element in control, the finished material possesses the uniformity of quality which cannot be achieved with other processes; but perhaps most importantly, the price of the board reflects all of the economies that derive from continuous and automatic production.

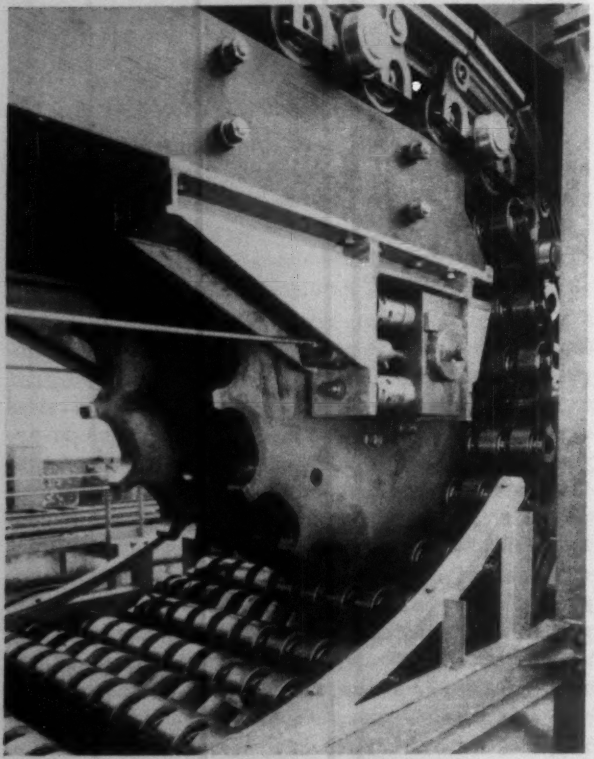


Fig. 7—Details of the guide sprockets, platens and roller bearings at lower entry end of press. Roller bearings ride on rails in passing through press.

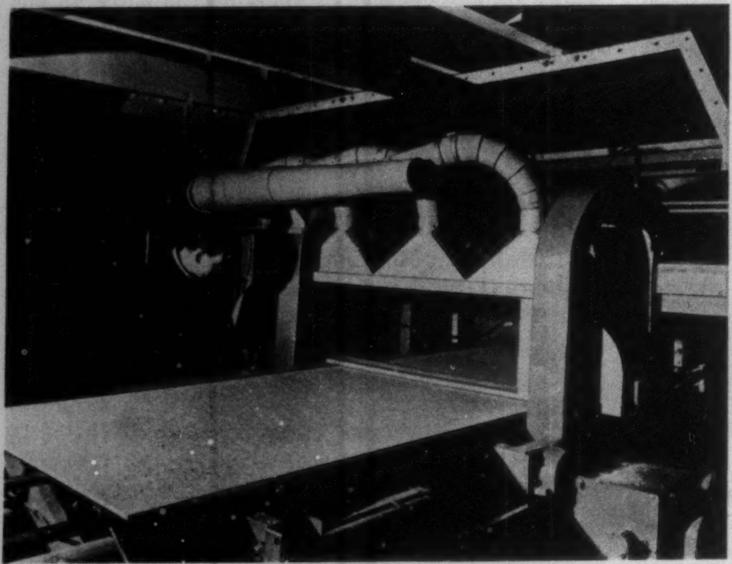
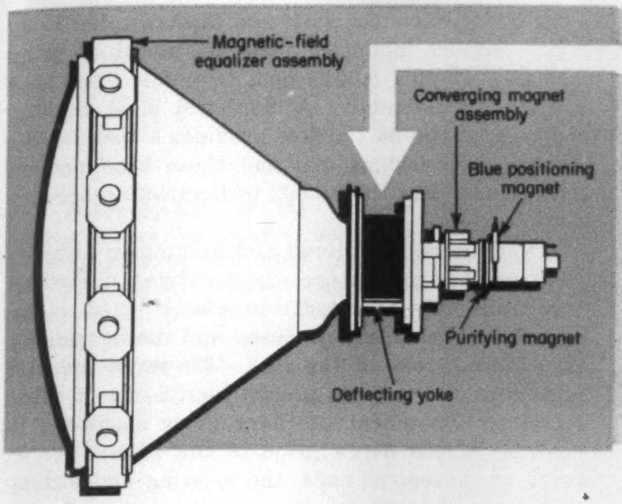


Fig. 8—As final operation, edge of board is trimmed to 4 foot width and cut to desired lengths. Between 25 and 40 million square feet of board can be produced annually by press, depending upon the thickness desired.



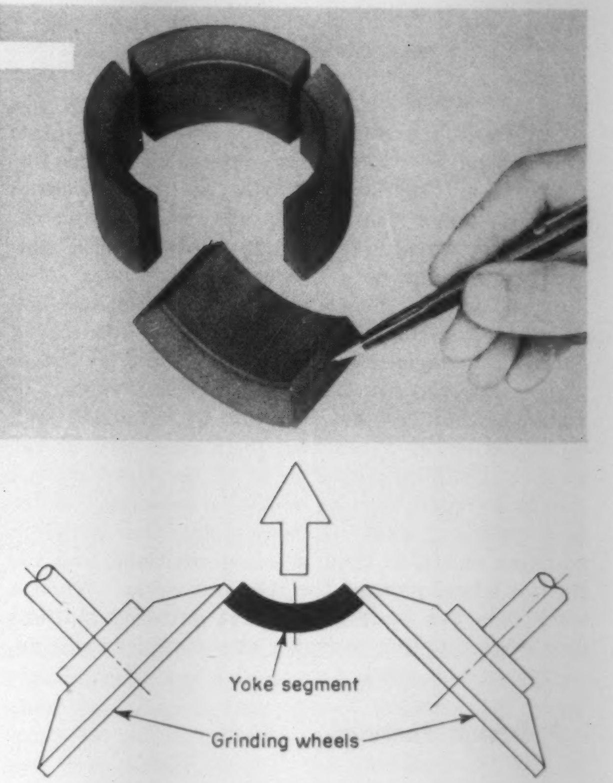


Fig. 1—Segments of deflecting yokes for color television picture tubes are made of a sintered ferrite mix. So that the parts will form a cylinder having the desired characteristics, the end faces indicated in the photograph must be ground to accurate angles with surface finish of 16 microinches rms and flatness within 20 millionths.

ELECTROHYDRAULIC SYSTEM CYCLES AUTOMATIC GRINDER

LIKE OTHER progressive manufacturers, Radio Corp. of America continually improves the efficiency of its manufacturing methods so it can offer its products at prices attractive to consumers. One of the current projects at RCA is the production of special deflecting yokes for use in their color television sets.

Each deflecting yoke consists of four coils on a core composed of four segments to provide the desired characteristics. The core segments are molded from a special ferrite mix and sintered. After firing, these parts are hard enough to cut glass, but performance requirements demand that the mating surfaces match very accurately so that four segments will form an accurate cylinder, *Fig.* 1. Accurate grinding is therefore required on both ends of each segment to produce smooth surfaces and true mating angles.

This operation is being performed by RCA on yokes for black and white units by means of special machinery previously engineered and constructed in their own plant. The color core segments did not fit on that equipment because of physical size, so another special machine tool was desired. Since their own equipment development section was overloaded, RCA called in the DoALL Co. After agreement was reached between the two concerns on a machine designed to grind the segments, DoALL built it.

▶ The Job Performed

Illustrated in *Figs.* 2 and 3 is the machine which was developed. It automatically loads the part on a fixture, aligns it, grinds both ends simultaneously in three successive grinds, and discharges it. Specifications call for finish of 16 microinches rms, flatness within 20 millionths across mating surfaces, and maintenance of 90 degree angle between ends of a segment within 50 microinches deviation over the ⅞-inch width of an end. Production rate is set at one piece every three seconds.

Molded segments are placed in a vertical hopper with their ends facing out from the machine. A hydraulic cylinder at the base of the hopper pushes the bottom segment into a fixture and operates a lever so that the part is clamped in place. The fixture is one of 36 mounted on the periphery of a 48-inch index wheel which rotates in a vertical plane. Six grinding spindles are paired to form three grinding stations along the path of the fixtures from the loading point to the discharge station. After the loading motion is completed, the fixture wheel is indexed 10 degrees and is positively positioned by a hydraulically actuated locking pin. With the index wheel securely locked, diamond cup-shaped grinding wheels are moved across the segment faces by hydraulic cylinders which slide the spindles along precision ways.

At the first grinding station all but 0.035 inch of excess stock is removed from each end; at the second, 0.025 inch more; and at the third station the final 0.010 inch of stock is removed. After the grinding pass is completed, the grinding spindles return to their starting positions, and the fixture wheel indexes for the next cycle. When a workpiece has passed the three grinding stations it is ejected onto a conveyor at a discharge station.

▶ Design Features

This segment grinder incorporates the same construction principles and many of the same components used in standard grinders. To obtain desired finishes and maintain tight dimensional control, balanced mass is provided in the grinder's structure. The work holding wheel is carried by a 5-inch diameter steel shaft and tapered roller bearings. Fixture mounting pads are machined to an accuracy of plus 0.0015 inch to minus 0.000 inch across the diameter. A hardened steel bushing for each of the 36 fixtures provides a seat for the locating and locking pin and these bushings are located with less than 0.002 inch variation between centers.

A hydraulically powered rack and pinion arrangement indexes the fixture wheel, driving it through a hydraulically actuated cone clutch which is engaged for the indexing stroke and disengaged for the return stroke of the rack. Throw of the rack is adjustable to obtain precise increments of wheel rotation. Movement of the rack is cushioned to provide smooth deceleration of the wheel. As an indexing movement ends, the locating and locking pin is moved by hydraulic power to engage the associated bushing in the index wheel. Another cylinder simultaneously applies pressure against the opposite side of the wheel to prevent any deflection that might be caused by the pressure of the locking pin against the wheel. A short taper on the pin and bushings gives a self-centering action. Large mass, rigidity and positive locking of the index wheel before a grinding pass contribute to the accuracy of finish and dimension obtained on this machine.

Fixtures on this job must handle sintered workpieces which are very hard, brittle, rough and vary in shape due to distortion that takes place during the sintering operation. Since the grinding is performed by diamond wheels, the fixtures must with-

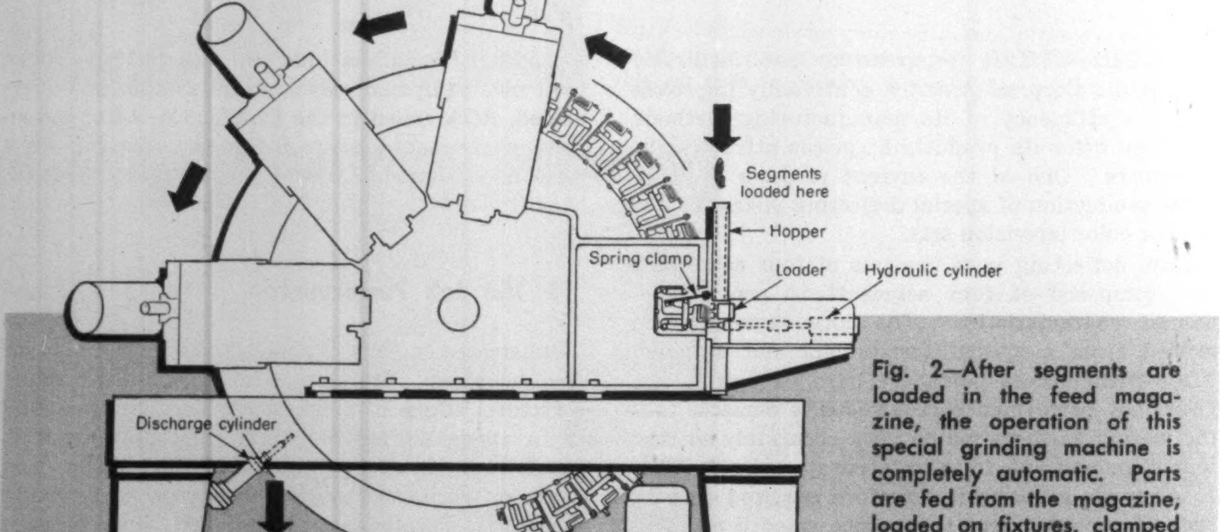


Fig. 2—After segments are loaded in the feed magazine, the operation of this special grinding machine is completely automatic. Parts are fed from the magazine, loaded on fixtures, clamped in place, indexed through three grinding stations, and discharged onto a conveyor running through a coolant tank.

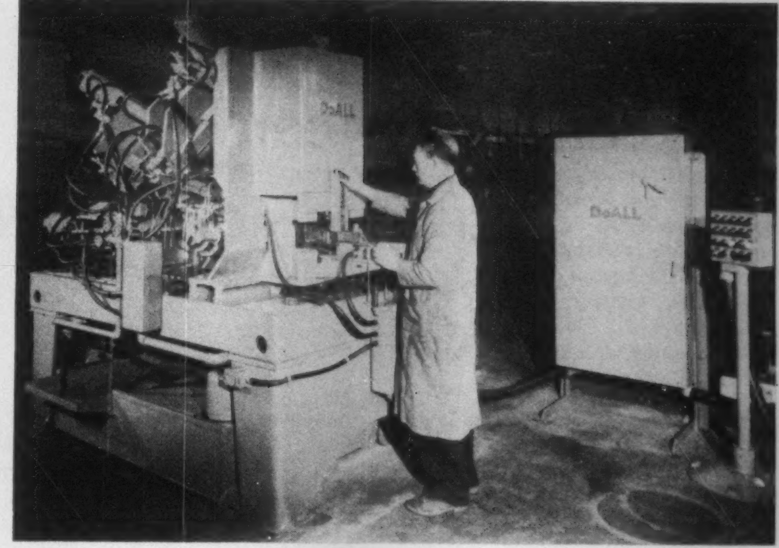


Fig. 3—Photograph of the machine shows some of the grinding units. Six grinding spindles are used, one on each side of the fixture indexing wheel at three grinding stations. Cup-shaped diamond wheels are used to remove the hard excess stock.

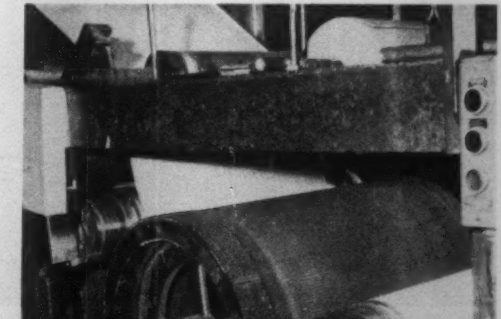
stand a flood of highly abrasive grit-laden coolant, and must also be strong enough to rigidly support the workpieces under grinding loads. The fixtures used to meet these requirements have locating pads of hardened tool steel designed for easy replacement. Adjustment has been provided to permit compensation for variations between runs of the sintered parts. The part is held in place by a lever-actuated spring clamp device. Hardened fingers which contact the tapered lip of the segment are attached to a leaf spring. An arm and wedge linkage actuated by the hydraulic loader locks the spring mounted fingers against the piece. In unloading, a second arm is actuated by the hydraulic discharge mechanism, and the locking wedge is withdrawn, releasing the part. The finished part drops on a conveyor running through a coolant tank in the bottom of the machine.

Grinding spindles in the machine are standard 1½-hp cartridge type units used on other grinders. Integral drive motors and tapered roller bearings give the units considerable power for their size. Tapered bearings are used to withstand the axial loads occurring in this type of grinding and were preloaded in assembly to maintain total runout of less than 0.0002 inch at the spindle nose with a minimum temperature rise under continuous operation. Permanent lubricant and special oil seals make the bearings serve for the life of the spindle.

Spindle columns are long and hand scraped to fit heavy ways. Both sliding and fixed members of the spindle units, as well as other castings on the machine, are cast of nickel-chrome iron for stability and wearing qualities. A metered automatic lubrication system for all the ways is provided.

Development of this special machine which will hold tight tolerances in production of large quantities of segments is of real value in the color television field. Just as in any other field, such a development increases the availability of finished products for consumers, at costs which permit more attractive prices to the customers.

Covered Rolls Prevent Slippage



PHYSICAL charactertistics of materials often suggest uses beyond those for which the product was designed. Thermoid Co., Trenton, N. J., manufactures a conveyor belt with the trade name of "Ruff-Top"—a descriptive term which refers to the nonslip characteristics of the belt. A typical use of this belt is in a conveyor carrying light parcels up and down inclines.

In the manufacture of abrasive belts, Behr-Manning Corp. encountered a problem in maintaining a proper tension on the continuously moving strip being coated with abrasive materials. Means used to prevent slippage failed to stand up in use. Solution—in the processing equipment, rolls of various diameters (6 to 30 inches) have been covered with Thermoid conveyor belting. The covered rollers prevent slippage of the abrasive belt as it passes through various processing steps from coating to drying oven and, in use, have shown satisfactory wear characteristics.

CONTINUOUS CONVEYORS MECHANIZE MOTOR MANUFACTURE

ONE STEP toward automation which small as well as large plants can find practical is the use of mechanized handling equipment. Whether operations on the product are performed manually, semi-automatically, or automatically, the parts must be moved between operations, and assemblies and packaged products must travel to shipping points and places of use.

An illustration of the importance of the in-plant transportation element is the case of the Electric Motor Division plant of the A. O. Smith Corp. in Tipp City, Ohio. With no expansion in floor space it now has twice the productive capacity it had when it was built five years ago, and the 90,000 square feet of plant are said to produce the greatest dollar volume per square foot in their industry.

Much of this achievement is due to improved manufacturing processes and simplified motor designs, but the plant is far from being completely automatic and the products still look like electric motors. A large share of the credit for improvement is ascribed to a third factor—use of flexible conveyor lines. Parts and materials move on conveyors, most of them overhead, from the moment they arrive at the plant door until they emerge as finished motors at the shipping dock.

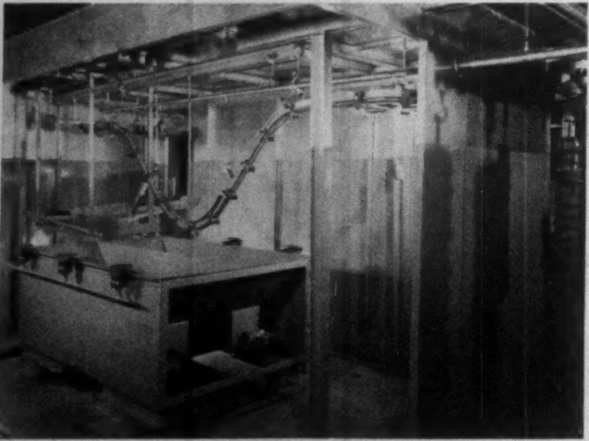


Fig. 1—One of the automatic processes possible with overhead conveyors is shown by this example of a dip painting operation installed to coat motor end frames. Continuous conveyors in general offer transportation, storage, and visual inventory features.

Lightweight cable type conveyors with standard parts and attachments, made by the Tipp Mfg. Co., comprise approximately 85 per cent of the overhead installation. Over the life of the plant, the management has found it relatively easy to remove the conveyors from the building structure, revamp and add to them when necessary, and reinstall in new configurations. Major changes have been made over weekends without any interruption of production the following week.

According to the assistant division manager, the overhead conveyors not only "bring materials where you want them when you need them," but also in effect add the equivalent of at least 25 per cent of the floor space for storage and make a visual inventory check easy. In one machining area 4000 square feet of floor space were required until overhead conveyors were installed so that the same operations could be performed in 2400 square feet. Approximately 6000 square feet of floor space were formerly used for temporary storage of basic motor assemblies. Now these parts move around on continuous overhead conveyors and the floor space is used for manufacturing operations.

A key point in the conveying system in this plant is the dispatching arrangement. Formerly most of the parts were brought to the assembly line in carts. Up to 15 men worked as dispatchers at the head of the assembly line collecting matching parts out of the carts. Now the components move from their production lines by overhead conveyors to a dispatcher's mezzanine. One man on this mezzanine works from production control schedules and parts lists and hangs a matching set of components on overhead conveyor hangers which move past him to the final assembly line. Purchased parts are added to the conveyor hangers as they move through a purchased parts stock room. Thus a worker on final assembly merely removes components from a single conveyor hanger and has the essential elements for putting together a motor. As a refinement of the handling process, an unloader has been built to automatically remove hangers from the conveyor at the assembly stations. A further benefit of the handling system has also been pointed out by the assistant division manager who said, "The system we now have may seem complex when you look at it from a distance, but it makes things easy for the men and women who work with it every day."

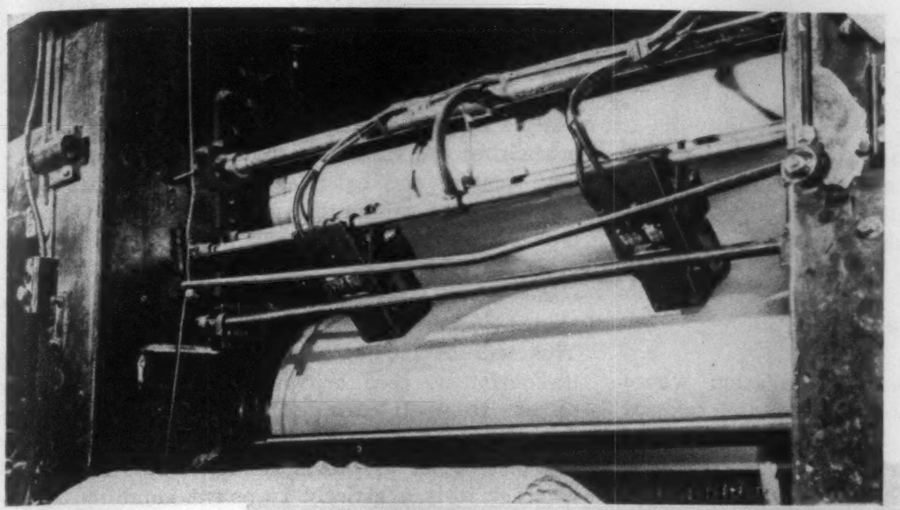


Fig. 1—Radiation gage installation to measure the thickness of both right and left sides of the sheet continuously. Development has advanced from simple gaging to incorporation of radiation gaging equipment in a feedback system that automatically controls sheet thickness.

Often the real appreciation for automation developments is lost because we are not familiar with the past difficulties of the unautomated conditions. Here is a *before* and *after* story —with a reminder that the *after* of today is the *before* of tomorrow.

RADIATION GAGING OF PLASTIC SHEET

SHOWS EVOLUTION OF FEEDBACK CONTROL

By W. HARRISON FAULKNER and GEORGE E. McKEWEN
Chief Engineer Sales Manager
Industrial Division, Tracerlab Inc. Boston, Mass.

WHILE THE FULLY AUTOMATED plastic sheet or film plant is still in the future, quality control and production men do not have to wait until then to enjoy the benefits of automation. Available today are automatic controls and automatic production analyzers which bring us to the threshold of the automated production line for sheet and film. Purists will say that anything short of the "ultimate" should not be called automation, but the fact remains that in terms of cold dollars and cents and pounds and yards of production, many of the advantages that we associate with automation are and have been available.

To review briefly the history of this development, one of the first steps in the improvement of plastic sheet and film thickness control was the development of continuous noncontact measurement by radiation gages, *Fig.* 1. Over seven years ago, Tracerlab developed Beta radiation gages; one was used on a plastic film line of a New England manufacturer early in 1949. Since then, similar gages have been used increasingly by manufacturers of film, sheet and plastic coated products. It must be acknowledged that Beta gages and their associated automatic controls can be expensive, but they pay for themselves quickly by savings on raw materials, greater output, and other ways to be mentioned later. Before getting into the economics of the situation, however, let's trace the evolution of modern Beta gage installations and see just what these gages do.

From Manual to Automatic

A typical plastic calender installation where thickness is controlled by sampling and manual control is shown in *Fig.* 2. It is usual in this type of operation to obtain a right and left hand sample from each roll. The thickness, or weight per unit area, of these samples is checked and the information obtained relayed to the calender operator, who attempts to initiate the desired correction by means of pushbutton calender motor controls, or manual screws.

This system suffers from a number of limitations, the most serious of which is the infrequency of the sampling and the difficulty of interpreting the effect of the correction introduced by the operator. When the calender is running smoothly, calendering equipment is in new condition and all units have stabilized, it may be possible to hold quite close tolerances using this method of control, but even with such ideal installations, a start-up or change of thickness of material may result in production of excessive scrap.

A manual control system to which continuous gaging equipment has been added is shown in *Fig.* 3. The gaging equipment is arranged to display the sheet thickness or weight per unit area of both right and left sides of the sheet continuously. Equipped with this continuous means of evaluating the finished product, the operator may now control the calender much more efficiently than with the sampling system. Improving his control through experience will lead to the development of skills and judgment. In continuously observing the product, he will learn that certain things occur which result in transient deviations. This will be particularly true in calenders using discontinuous feed or where frequent shutdowns occur. He will learn that it is advantageous to wait for a brief period when he notes a deviation to see whether the deviation represents a trend or whether it is a strictly transient condition which will result in only a short piece of off gage material.

Should the deviation continue for a period of time sufficient to convince him that the error was not of a transient nature, the calender operator would then attempt to introduce a correction of the proper magnitude to offset the observed error. He would develop skill in judging the exact amount of time to apply the correction to offset any observed error. He would also learn that having introduced the correction he must then wait a period of time sufficient to allow the material to move from the calender through the cooling unit to reach the Beta gage and indicate the new value of thickness.

In practice, he would probably wait until the change had apparently leveled out and in most instances this method of operation would prevent

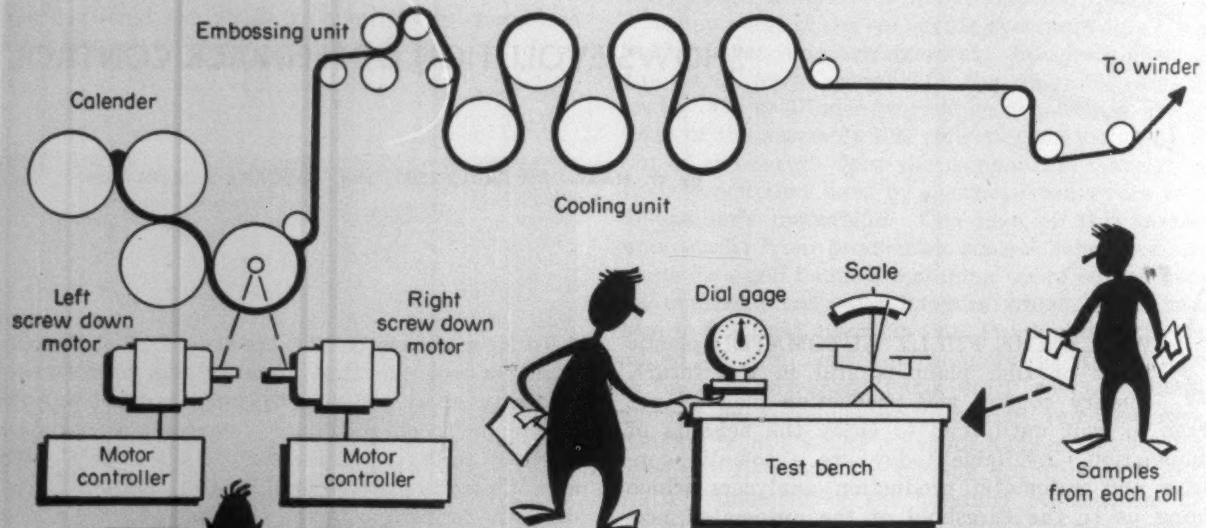


Fig. 2—Calender system previous to installation of radiation gaging and automatic controls. Obviously, the educated guess was the real means of control.

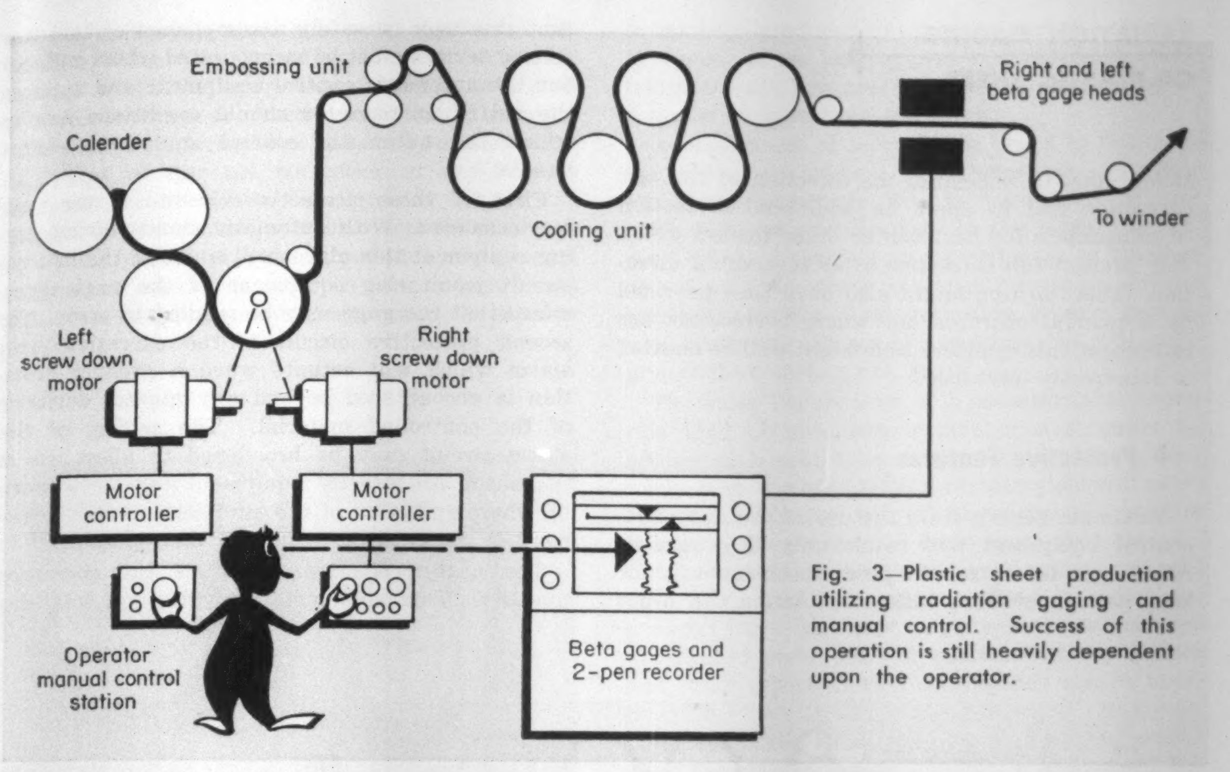


Fig. 3—Plastic sheet production utilizing radiation gaging and manual control. Success of this operation is still heavily dependent upon the operator.

overshoot; or he might learn to correlate calender speed with the delay time needed before introducing further corrections. His skill should allow him to correct for routine slow trends in product thickness without excessive overshoot or excessive delay, but during start-up or change of gage he would probably misjudge the waiting time required and aggravate the situation by introducing corrections which would result in overshoot.

However, perhaps the most serious limitation of manual control from gage information is the fact that optimum results require continuous monitoring by a completely alert operator and the quality of the product produced will be greatly influenced by operator fatigue and other human factors.

▶ Today's System

The automatic control system shown in *Fig.* 4 is designed to perform the functions provided by the perfect operator continuously and tirelessly and to provide a degree of judgment and accuracy beyond that which can be achieved by even the most skilled manual control. Gage information from both the right and left sides of the sheet is applied continuously to the automatic control equipment. In order to prevent an undesirably large number of screwdown motor correction cycles, it is usual in either a manual or automatic control system to establish a small zone within which the material may fluctuate without calling for control action. Within this dead zone no control action is taken and the calender is allowed to run as set.

As soon as the gage indicates a deviation exceeding the allowable dead zone width, a precorrection lag circuit is actuated. This circuit delays correction for a time sufficient to establish that the deviation is not of a transient nature and that the error has existed continuously for this time. Having determined that the error is not of a transient nature, the correction time circuit is actuated. This circuit operates the screwdown motor through the motor controller for a length of time sufficient to offset the observed error. Should the gage indicate that the material being measured has returned to the dead zone during this part of the cycle, the correction would be immediately discontinued. At the end of the correction cycle the screwdown motors are stopped and a short, fixed time delay is introduced to compensate for the response time of the gaging equipment or other fixed lags.

This is followed by a synchronized delay time which compensates for the distance between the calender and the gage and is held continuously proportional to the sheet speed so that the time delay introduced is no longer than that which is actually required to transport the sheet from the calender to the gage. If an error is still found to exist at the end of this waiting period, further correction is introduced and the cycle repeated until the product returns to the dead zone.

Use of the dual system of control results in minimizing the effect which may occur on the left side when the right side is corrected, or vice versa, since the duplicate control system on the other side of the calender will commence correction automatically as soon as the reaction results in a deviation exceeding the allowable dead zone.

The automatic control equipment may also be called upon to remember the direction of the last correction and to apply an additional correction to compensate for backlash or other factors which may prevent full correction after reversal of direction. This function might also have been provided by a manual operator but where corrections are infrequent this compensation might well be omitted or incorrectly introduced.

▶ Protective Features

Maximum benefit from the use of the automatic control equipment will result only if it can be relied upon to control the product continuously for long periods of time without attention. In order that this may be safely accomplished certain protective devices must be incorporated which will lock out the automatic control equipment and summon the aid of an operator should conditions develop which the automatic control equipment cannot handle.

First of these protective circuits is the gage service alarm. With automatic standardizing gaging equipment this alarm will sound if the internal circuit monitoring equipment of the gage determines that the gage may be reading in error. The second protective circuit is the excessive error alarm which will actuate when a product deviation is encountered beyond any normal deviation of the controlled material. The setting of this alarm circuit may be broadened to allow use of the automatic control equipment for quick start-up where operation of the automatic control equipment is monitored by the machine operator.

The next protective circuit is the correction totalizer. This equipment provides for totalizing

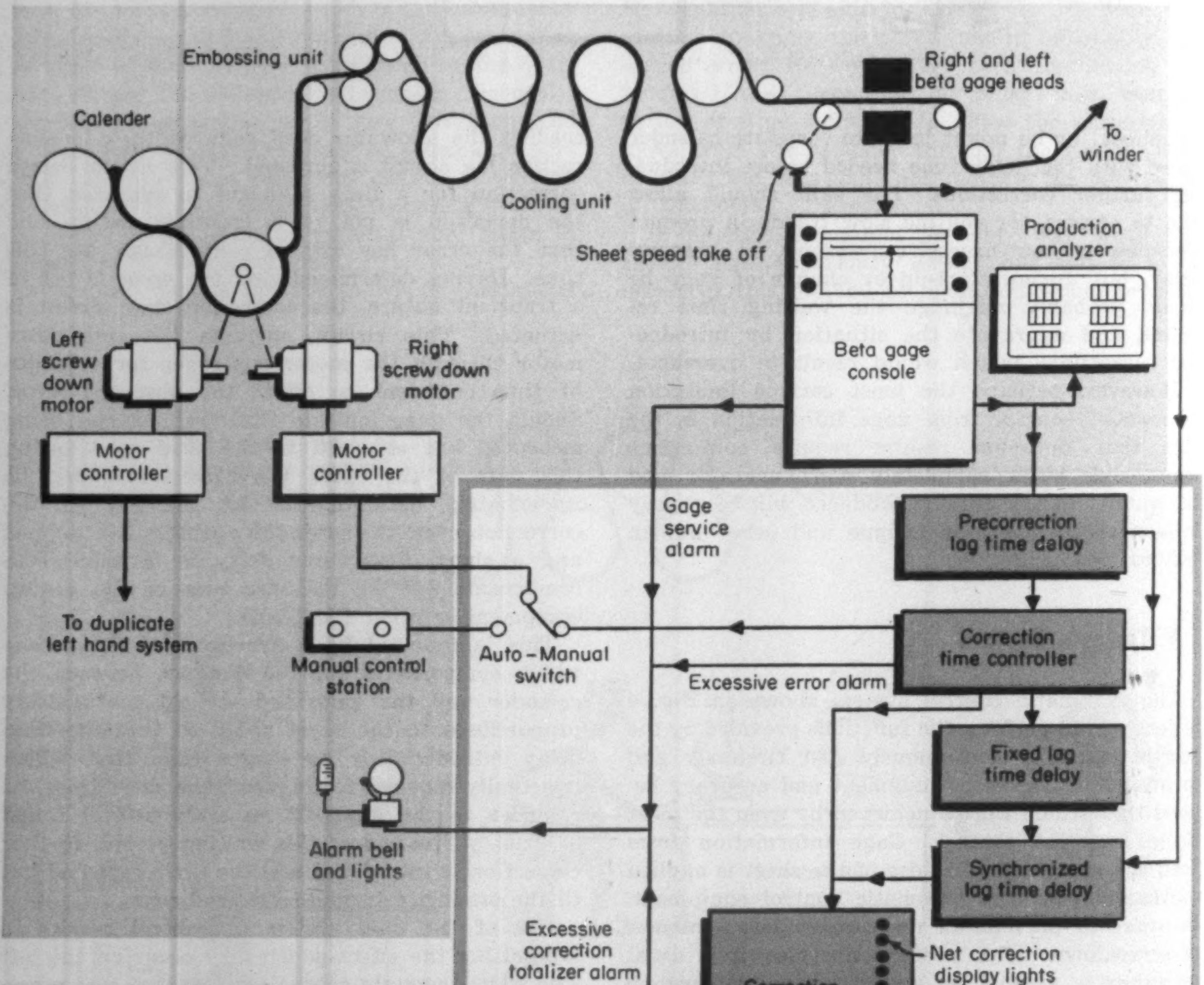

Embossing unit
Right and left beta gage heads
Calender
To winder
Cooling unit
Sheet speed take off
Production analyzer
Left screw down motor
Right screw down motor
Beta gage console
Motor controller
Motor controller
Gage service alarm
Precorrection lag time delay
To duplicate left hand system
Correction time controller
Manual control station
Auto-Manual switch
Excessive error alarm
Fixed lag time delay
Alarm bell and lights
Synchronized lag time delay
Excessive correction totalizer alarm
Net correction display lights
Correction totalizer
Auto control console

Fig. 4—Automatic control system tracing the feedback path from the radiation gage to the screwdown motor. The dual system provides for control of uniform sheet thickness across the width.

the net correction that has been applied to the calender since the actuation of the automatic control. If this net correction exceeds a safe limit in either the up or down corrections, the automatic control is locked out and the alarm sounded. The value of this net correction at any time is displayed on a system of lights.

Units of the control system described can readily be adapted to provide output data for product analysis or can be modified to receive input data from process programming equipment in a thoroughly automated system. These features should provide the versatility required to permit future system changes without obsoleting present units —a very important consideration in view of the fact that the more complex systems can be very expensive.

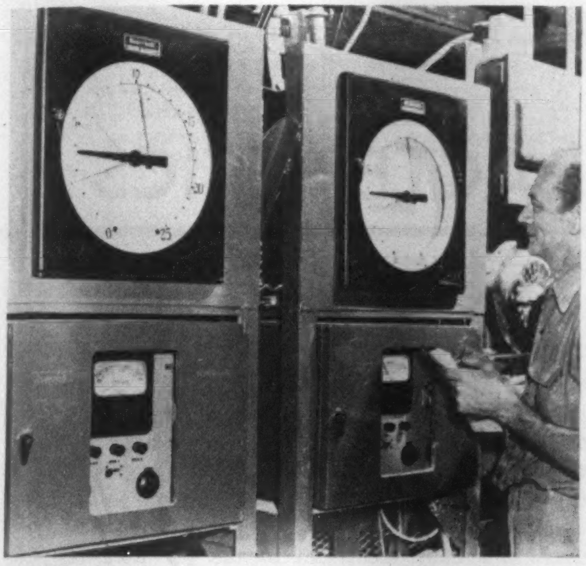


Fig. 5—Typical Beta gage console with per cent deviation indicated on lower instruments and history of run permanently recorded on circular recorder.

▶ Economic Advantages

With that thought we come to the economics of such a system. It is interesting to note that this automatic control system, specifically designed to improve quality and cut costs by improving yields, provides additional benefits to those manufacturers who are progressive enough to find them. For example, by the addition of a product analyzer the quality control department can have statistics available at any time during operation of the mill providing a summary figure of the number of yards or feet (or whatever unit of measurement is used) of the material produced, indicating how much of it has been produced to tolerance during any shift, how much is ten percent over or ten percent under tolerance, and how much is outside of tolerance by a factor of more than ten percent.

Another facet of information useful to the quality control department is obtained by comparing the chart recordings for the production of any shift with the specifications of the production order. Thus, if there is any question as to whether or not a certain order was manufactured to proper specifications, the chart recording gives a permanent historical reference containing the full pedigree of the complete run, *Fig.* 5.

The sales department of a manufacturer using this kind of automatic control system gains an additional benefit from the assurance that a customer who has stipulated a certain yield will surely get it. Proper use of the automatic control reassures the production department that the material is produced exactly to specifications and will yield the calculated amount. Since it is not uncommon for a customer to get rebates because his anticipated yield did not materialize, the dollars and cents aspect of this contingency can be readily seen.

On the other hand, the manufacturer of plastic sheet benefits from better yield. By means of the automatic gaging equipment, tolerances can be held closer, eliminating delivery of "over spec" material. Holding thickness to within a few per cent of desired product thickness, even on material which is only a few thousandths of an inch thick, enables the manufacturer to accumulate a considerable saving of raw material in the course of a week's production.

One of the primary considerations which has gone into Tracerlab's development of this gaging equipment has been the attitude and capabilities of the production line employees who must operate it. In the early days, automatic control equipment was of such a complex nature that only skilled engineers and technicians could be depended upon to use it properly. Now, however, with the simplified controls on the newest versions of these automatic control devices, production line employees can be taught to use them in a matter of a week or so. Since the basic components of the system are made from standard, long-life parts they are readily accessible when service is needed, unitized construction enables repairs to be made relatively easily and rapidly.

As mentioned at the beginning of this article, today's automatic control equipment hardly represents complete automation, but it is certainly a step in that direction. Production men, quality control engineers and mill superintendents who are interested in obtaining the benefits of automatic gaging need have no fear that they are invading unknown frontiers of science when using radiation gages for thickness control. Such gages and associated automatic controls have been proved through wide service in many industries and are an integral part of these process control systems.

POWER FOR AUTOMATION WITH DC DRIVES

Part 2

By V. R. MURPHY
Applications Engineer
Reliance Electric & Engineering Co.
Cleveland, Ohio

Important facts to the user are operating characteristics—what can be expected from the output and what is the required input. Here is such a "black box" discussion, with the box representing the dc drive.

DC DRIVE CHARACTERISTICS

ELEMENTS of dc drives and the signals used to control them were discussed in Part 1 of this series. With these points established, it seems logical to consider operating characteristics in order to appreciate the possible applications of dc motors.

Requirements of motor drives for various applications may be tabulated as shown in TABLE 1. It is very unlikely that many of these requirements would be combined for a single application; in fact some of them cannot be combined. The capabilities commonly known as adjustable speed, braking, jogging, remote control, and acceleration control, either singly or in combination, are the key requirements of most applications.

Often more than one operating speed is required and conditions are present that prohibit the use of simple gear shift. Possibly only zero and set speed are required but acceleration is critical. More often a range of easily adjusted speed is required. Dynamic braking is used in a high percentage of installations to provide safety stopping or good process control. Ability to operate at low speed for setup or threading is as important a factor as braking. Operation from some remote point or several points in parallel is sometimes necessary. Acceleration control, particularly in web processing industries, may be a determining factor.

Most of the items in TABLE 1 are self-explanatory. We might look at the few which do demand some explanation. Electrical braking may be dynamic, regenerative or "suicide" braking; these three means are unsurpassed for stopping a motor, and a friction brake is normally supplied where holding action is required. Current or torque limit means that it is possible to establish an adjustable but definite maximum current that a motor will pass. Precise regulation means that variations from set point can be held to very narrow limits regardless of changes in load, line voltage temperature and component values. Equipment is designed which provides sensitive response to signal and there are easy electrical means for delaying the effect of the signal.

It is impossible to discuss operating characteristics in only a qualitative sense and present information that is sufficient for the potential user. We need to be as specific as possible quantitatively in describing the various characteristics of performance. Therefore, each characteristic will be presented to include both the routine capabilities of dc drives and the special results obtained when design emphasis is placed on the particular performance characteristic under discussion.

Range of Speed Adjustment: A simple drive with armature control and no applied load is capable of operating over a speed range ratio of 8:1. The same drive with moderate, constant load is adjustable over a range ratio of 12:1. Addition of motor field control quadruples these ratios. Special wide range systems have speed ratios in the order of 100:1 with further extension by the addition of field control. Jogging speed can be set at any value within a particular speed range.

Horsepower Range: These motor drives are available in a horsepower range from approximately ¾ to 1000 hp. Specific construction features may vary, throughout the range but, in general, the difference is one of size. At motor speeds above base speed a constant horsepower range is available; below base speed a constant torque range is found (see *Fig.* 5, Part 1—AUTOMATION, April 1956).

Acceleration, Deceleration, Reversals: In the motor with normal start and stop characteristics, times required to reach operating speed from standstill and vice versa range from 1.5 to 5.0 seconds. Reversals, of course, are twice these times. Motors specially designed for rapid acceleration and deceleration reduce start or stop time to 0.2—0.5 seconds. Experimental work indicates that further reduction to 0.02—0.05 seconds is possible. However, in some instances start or stop times as long as several minutes are encountered. Generally speaking, the range of time in each instance represents smaller motors for the shorter time and larger motors for the longer.

TABLE 1
Requirements for Motor Drives

Adjustable speed
Constant torque or horsepower over a speed range
Acceleration control
Braking
Jogging
Current limit
Speed synchronization
Speed regulation
Load sharing in tandem operation
Response to control signals
Remote control
Maximum speeds

Maximum Speeds: Normal speed motors range from 4000 maximum rpm in the ¾ to 10 hp size, to 3500 rpm in the 10 to 40 hp size, to 2700 rpm in sizes over 40 hp. High speed motors are approaching about 8000 rpm maximum in all sizes.

Braking, Positioned Stopping: The requirement that a machine, and hence the drive motor, be stopped successively at the same angular shaft position is commonly known as positioned stopping. Normally this characteristic is not included in a standard dc drive; when it is required the motor shaft can be stopped within 5 degrees of the desired point by special design.

Current Limit: Sharpness of current limit is measured by the increase in current required to stall the motor over the current at the point where the motor speed begins to slow down, *Fig.* 1. The effect of differences in current limit on acceleration characteristics is also shown.

Position Control: Synchronization of speeds on long runs can be accomplished with negligible error. However, with simple position control (use of signal synchros and limited to relatively slow speeds, *Fig.* 2) transient error during start-ups may be large. With fine position control transient error is small and of short duration. Fine position control involves use of synchronization rheostats

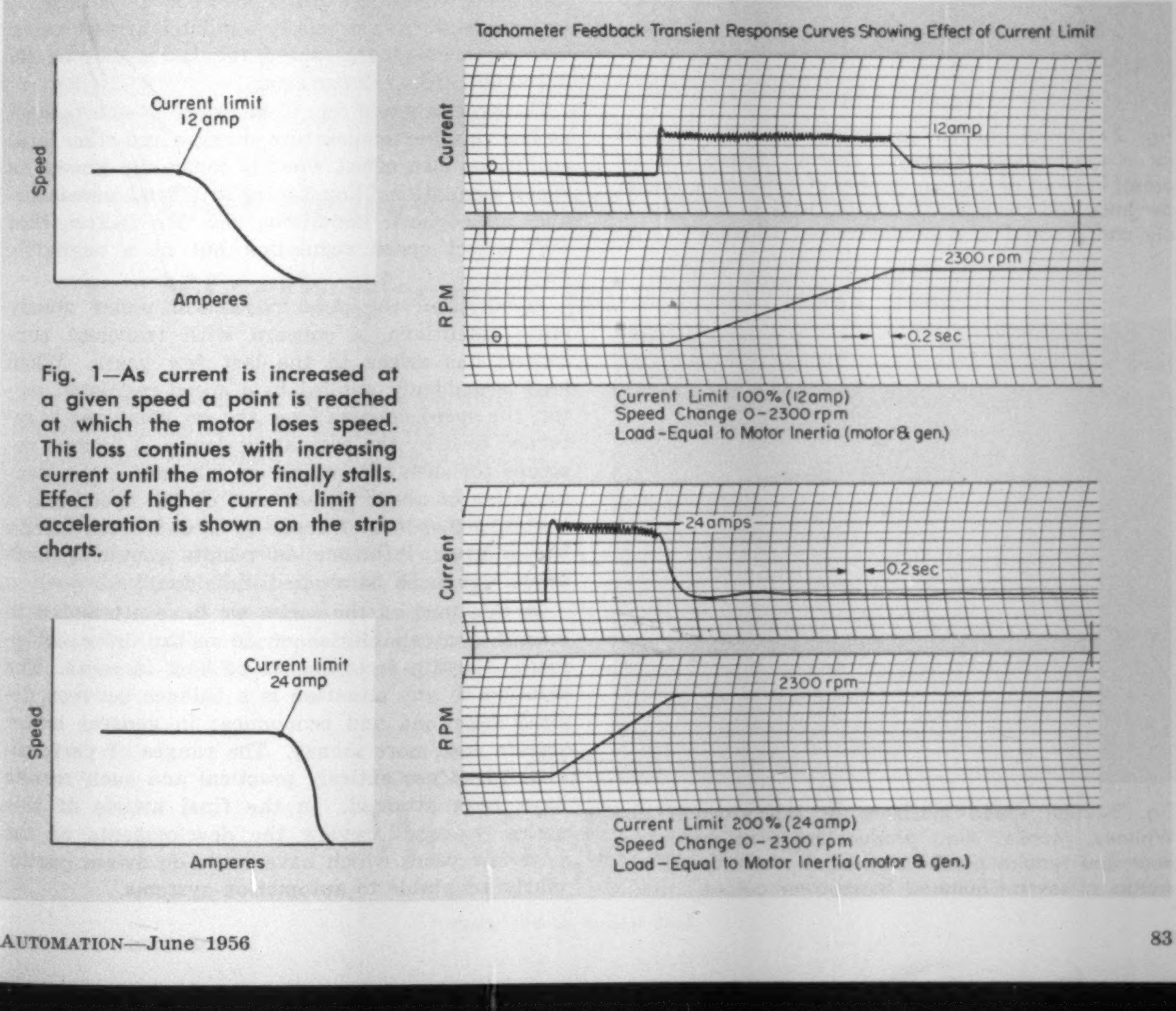


Fig. 1—As current is increased at a given speed a point is reached at which the motor loses speed. This loss continues with increasing current until the motor finally stalls. Effect of higher current limit on acceleration is shown on the strip charts.

operating from the output shaft of a mechanical differential. This degree of accuracy is required for drives used in paper machinery, *Fig.* 3.

Tandem Motor Operation: When motors are mechanically connected in tandem, the problem, of course, is not in synchronizing speed but in equalizing the load. With comparable conditions of mechanical load and lengths of wire to each tandem motor, the load will be shared within approximately 20 per cent of equal distribution. Rheostat adjustment of the motor field can balance this distribution very closely. Drift due to differences in motor heating or other causes will not be significant if the mechanical loads are reasonably stable. For best load control of a simple system over a speed range it is desirable to compensate for different wire lengths to the motors in order that each motor has the same applied voltage. When this is done on applications of relatively stable loads, the motors will share the load well within the tolerance allowed in selecting motor horsepower.

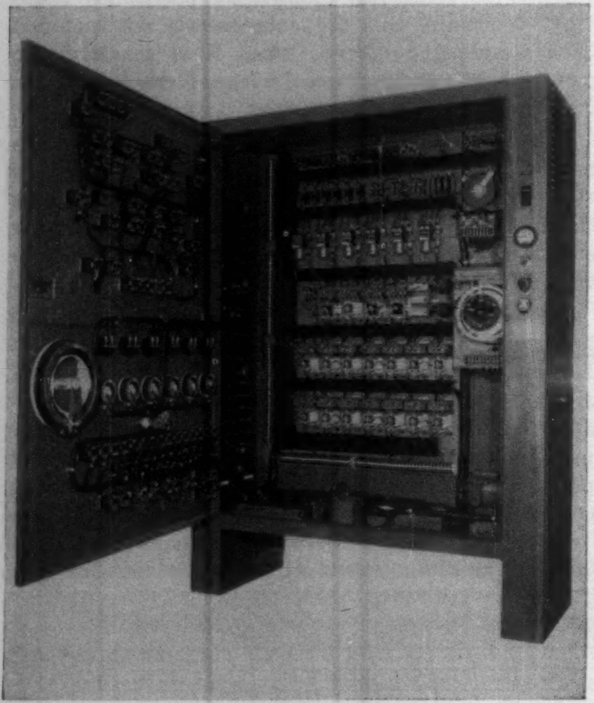


Fig. 2—Control cabinet containing dc motor controls for a synchronized conveyor system. Speed can be preset in terms of a given number of automobile bodies per hour and component parts per hour so that assembly can proceed to a predetermined schedule.

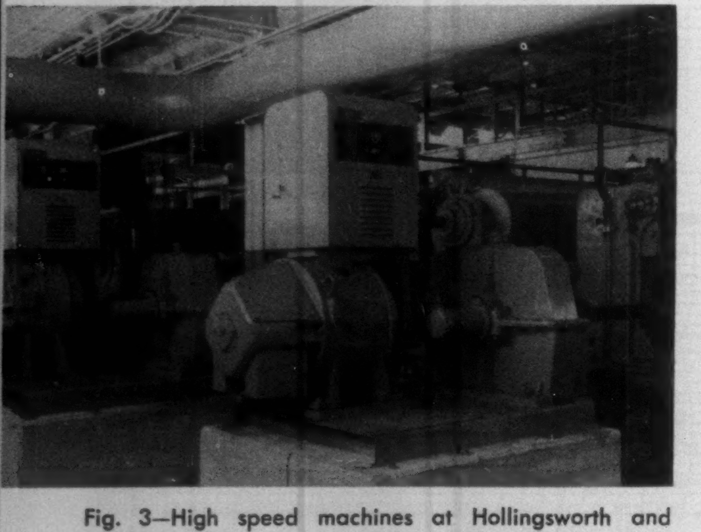


Fig. 3—High speed machines at Hollingsworth and Whitney, Mobile, Ala., produce miles of paper per hour and require precise control of motor speed with motors of several hundred horsepower output.

Effects of overall load change (not relative changes between motors), heating, and line voltage variations may result in an overall line speed variation beyond allowable tolerance. A severe accumulation of all these effects could result in a 5-10 per cent speed change from a given setting. Use of a tachometer feedback regulator governing lead motor speed can reduce overall line speed variation to ¼—½ per cent of set speed.

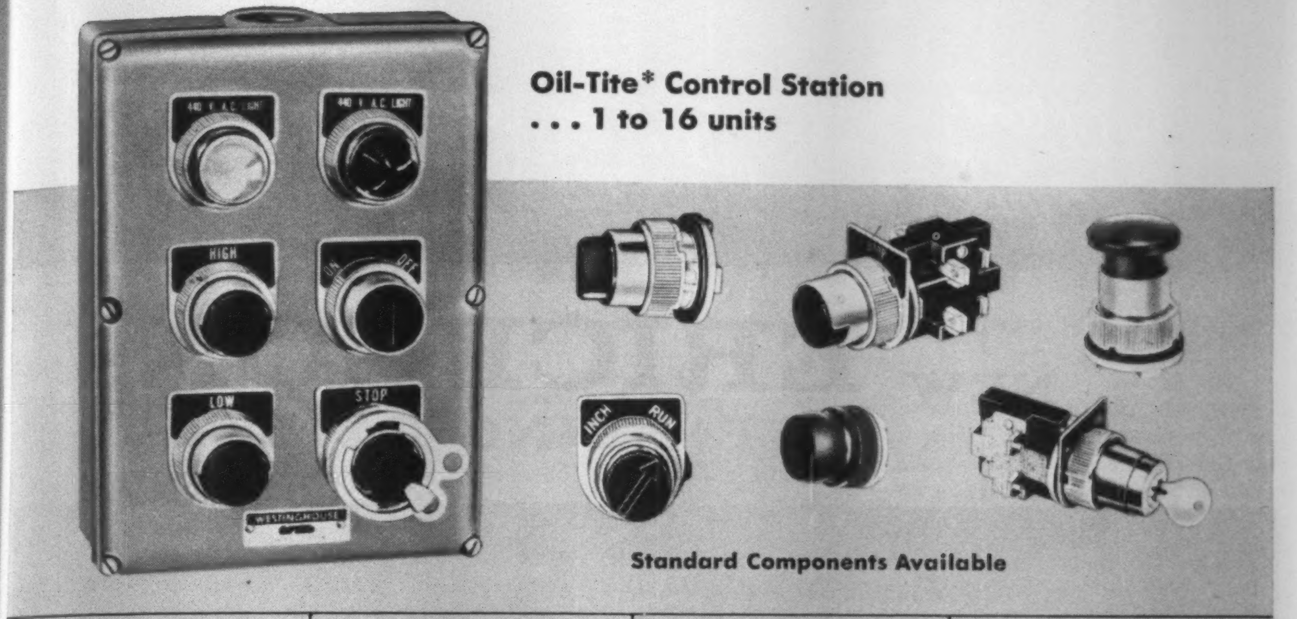
In the case of long conveyors the situation often exists that loads will be markedly different at different locations, and the loads cannot be predicted accurately in advance of operation. In such instances it is possible to provide rheostat control for balancing loads from a central location after the equipment is in operation.

Speed Regulation: In the simple system, speed regulation (difference between no load speed and full load speed compared to full load speed) is about 1 to 3 per cent. In a precisely regulated system using tachometer feedback, speed regulation can be reduced to 1/10—1/2 per cent.

Changes in speed due to measurable effects such as line voltage, temperature changes and other local conditions also effect what is commonly known as speed regulation. Long term drift and unmeasurable atmospheric conditions also are factors that may effect speed regulation but in a negligible degree.

In addition to speed regulation under steady state conditions, a concern with transient conditions has arisen in the last few years. When load is suddenly applied to a speed regulated motor, the speed departs from the set point and is returned to it by the regulating device. A system designed for such an application will have a transient deviation of about ½ per cent of full speed and a transient response of about ½ second. Load inertia has a great influence on results requiring that actual problems be studied individually.

In this part of the series we have attempted to outline the capabilities of dc motor drive equipment. Certain facts should be kept in mind. The solution to any situation is a balance between desired functions and economics; in general better results cost more money. The ranges of performance given are entirely practical and such results have been attained. In the final article of this series, we shall review the developments of the past few years which have made dc drives particularly adaptable to automation systems.



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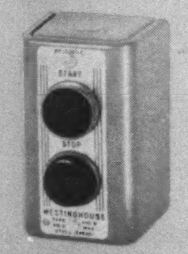
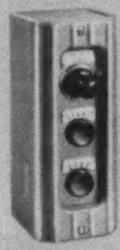
. . . 1 to 16 units**

Standard Components Available



Standard Duty

Available in one, two
and three unit stations.



Heavy Duty

Comes in a choice of from
one to seven unit stations.

Pendent Type

In standard, heavy duty
and Oil-Tite enclosures.

Special Service

Units for mining, steel
mills, extra heavy duty.

Get delivery now on complete Westinghouse pushbutton line

The most complete selection of pushbutton units in the industry—for standard or heavy duty, oiltight, pendent-type, and corrosion-resistant applications—now available for immediate shipment.

Standardized and interchangeable component parts quickly give you the right pushbutton for every application. Even the latest additions to the Westinghouse pushbutton line such as the new and unique Push-to-Test indicating light, which permits an immediate check for burned-out bulbs, are always available right "off the shelf". Immediate delivery also available on a choice of enclosures for surface, flush or pendent mounting—for indoor, outdoor, water and dust-tight, oil-immersed or corrosion-resistant applications.

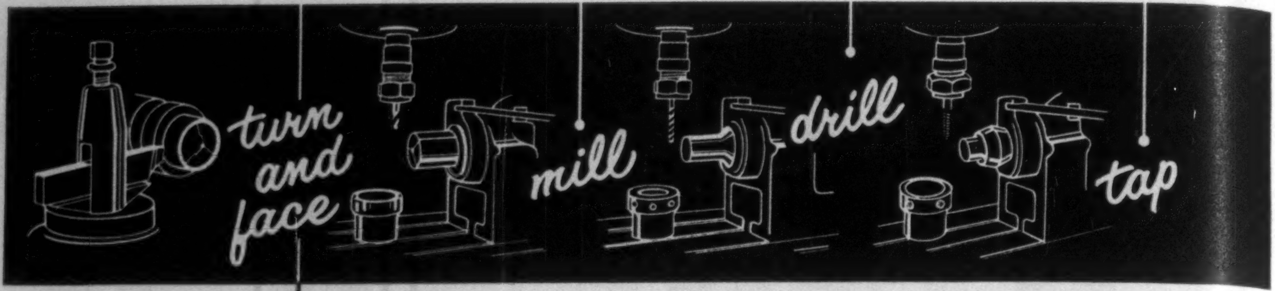
Order Westinghouse pushbuttons *today*—get 'em *tomorrow* (or sooner), right off the shelf. Call the control sales engineer at your nearest Westinghouse office, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa., and ask for descriptive bulletin 15-000.

J-30191-A

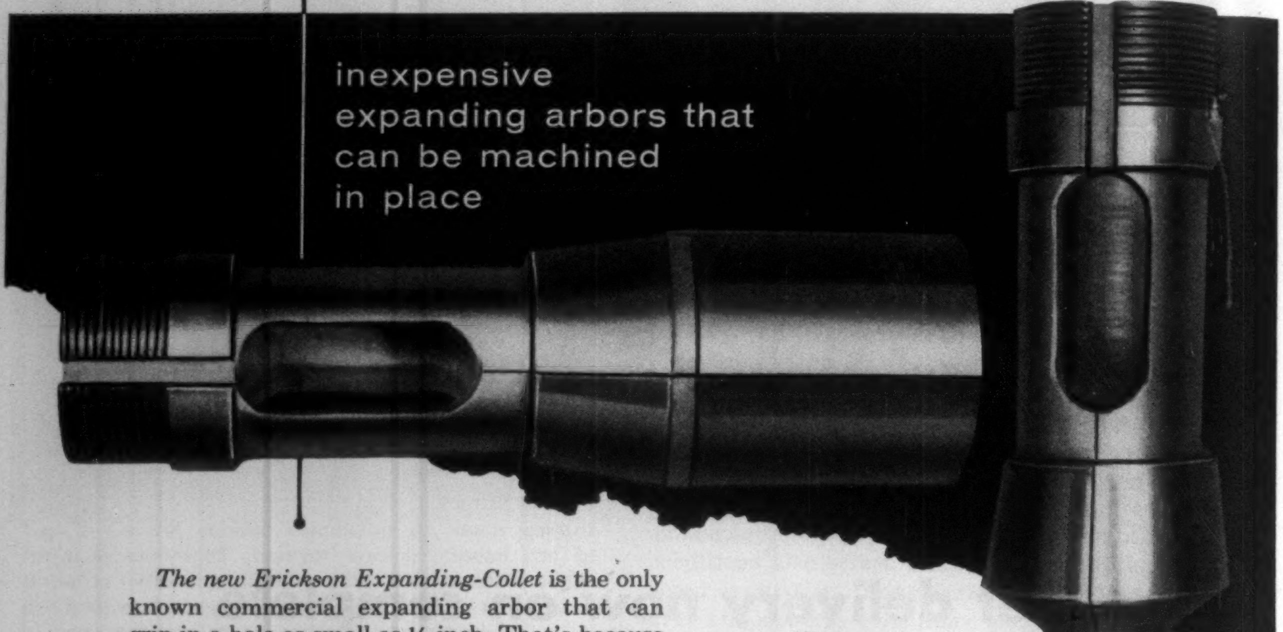
*Trade Mark

YOU CAN BE *SURE*...IF IT'S
Westinghouse

Circle 579 on Inquiry Card



NEW **ERICKSON**
EXPANDING-COLLETS



inexpensive
expanding arbors that
can be machined
in place

The new Erickson Expanding-Collet is the only known commercial expanding arbor that can grip in a hole as small as ⅛ inch. That's because it's a one-piece arbor actuated in the same manner as a reversed collet . . . a collet which grips the workpiece on the *inside surface*. Because of its one-piece design without drawpin, it gives maximum wall thickness and full gripping power equal to that of a collet.

That means you can convert your machine to internal chucking by merely inserting the new Erickson Expanding-Collet. And since it is machined in place on the machine, it gives greatest possible accuracy . . . can be re-machined for new jobs . . . solves the rush-order problem.

Order a stock of new Erickson Expanding-Collets. They'll save your time, your temper and your money.

AA-3361

Write for your free copy of "*Erickson Expanding-Collet*" today. And also request "Catalog K"; you'll find cost-slashing applications for all Erickson holding tools.

APPLICATIONS

LATHES • TURRET LATHES • SCREW MACHINES
SPEED LATHES • AUTOMATIC CHUCKING MACHINES
BURRING MACHINES • MILLING MACHINES • DRILL PRESSES
CUTTER AND CYLINDRICAL GRINDERS • GEAR CUTTERS
INDEXING HEADS • COLLET CHUCKS • ETC.

ERICKSON TOOL COMPANY

2307-6 Hamilton Avenue • Cleveland 14, Ohio

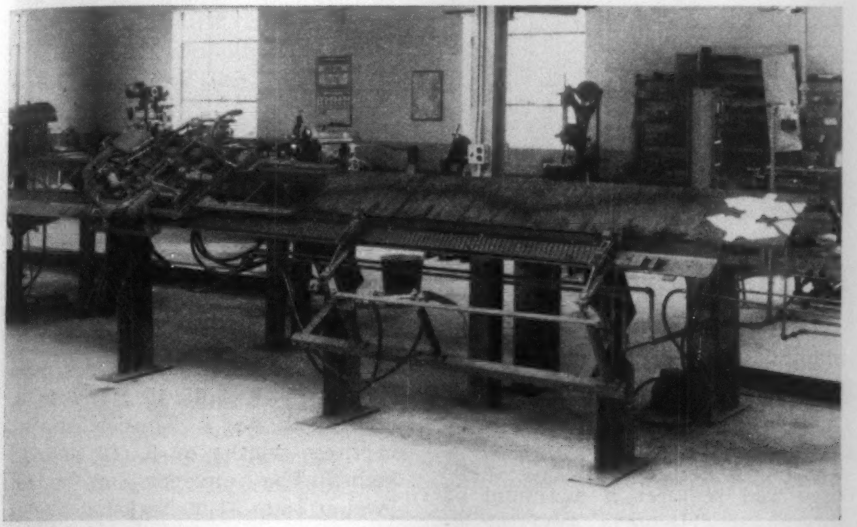
COLLET CHUCKS • FLOATING HOLDERS • TAP CHUCKS • TAP HOLDERS • AIR-OPERATED CHUCKS
EXPANDING MANDRELS • EXPANDING-COLLETS • SPECIAL HOLDING FIXTURES

Circle 580 on Inquiry Card

AUTOMATION new equipment

Machines and plant equipment designed for more automatic operations

For detailed information and literature, use card page 17



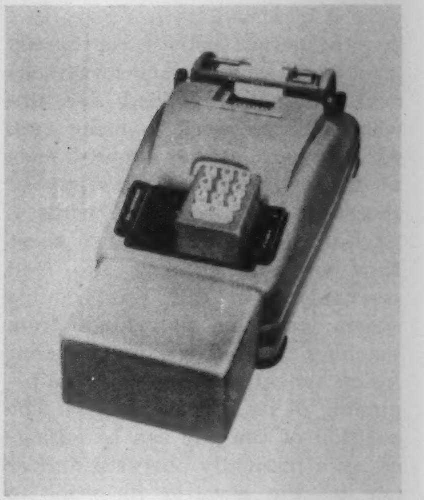
Automatic Feeder for Blanking and Shearing

Designed for use in blanking, shearing and secondary operations, automatic feeder is operated on a small amount of compressed air. In feeding a plate of any length, thickness or width, stop pins are set in permanent, graduated template bars to correspond to the center of the blank to be cut. A valve lever is then thrown and the carriage moves rapidly along the spacing table. Every time the carriage contacts a pin, the press or shear operates. In some cases one operator can run several presses. With this device, blanks of irregular shape can be cut with a saving in material. The feeder can also be used for blanking on both forward and return travel of carriage. In operation where blank elimination makes fully automatic feeding inadvisable, the machine can be made to run semiautomatically by throwing two valve levers. Illustrated feeder is equipped with a table inclined 30 degrees to operate with an inclined press. The table can be quickly lowered or raised to adjust to new die levels. Tables are available for feeding to flat bed presses and shears. Feeder shown is also equipped with plate guide rollers which automatically advance and retreat as the carriage moves along the table. Jaws which grip the work to be blanked or sheared can be modified to push plates through a variety of dies. The plate shown is to be fed into a blanking press equipped with scrap cutters. The feeder can be designed to operate with any press or shear. No alteration to either press or shear is necessary. **Pollasky Engineering Co.,** 3802 N. 38th St., Milwaukee, Wis.

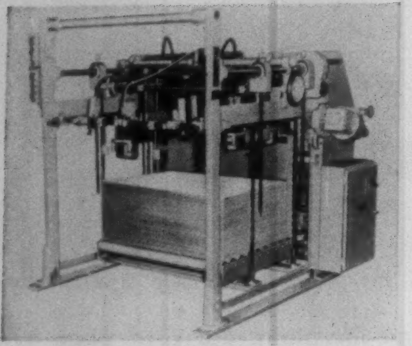
Circle 401 on Inquiry Card

Electric Totalizer

Designed for use with computers, digital converters and other electronic and mechanical equipment, remote electric totalizers have been installed as integral parts of large data processing systems and have produced excellent results in around-the-clock operations. Operating on information received electrically from most types of digital computer devices, the totalizer adds, subtracts, totalizes and prints both the entries and totals, and transmits the digital values and control functions to other data handling equipment for subsequent processing or storage. Among the various types of equipment for which the new machine was designed are: Electronic counters, weighing scales, key punches, tape and card punching and reading units, converters and electric typewriters. Additional features of the unit include control pulses, specifying the operation to be performed and which can be initiated remotely, and the electrical readout of the specific operation performed. The remote electric totalizer operates on an input pulse of 10 to 25 milliseconds at 120 v dc. The printing rate is 60 lines per minute with a digital output of up to 11 decimal digits in parallel. **Remington Rand Univac,** 1902 W. Minnehaha Ave., St. Paul W4, Minn.



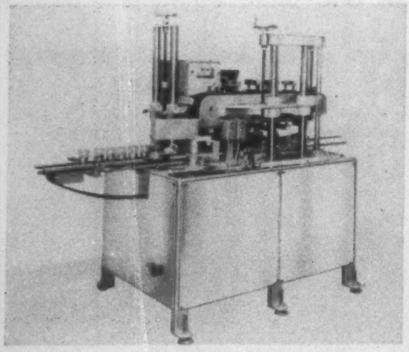
Circle 402 on Inquiry Card



Metal Sheet Feeder

Up to 150 metal sheets per minute are fed to such processing equipment as presses, coaters, slitters, shears and buffers by new feeder. Machine has a 9000-lb capacity elevator. Feeder may be equipped for either rear or side loading and a powered, fast lowering elevator reduces reloading time to approximately 20 seconds. Sheets handled range in thickness from 38 to 20 gage and in size from 19 by 19 inches to 44 by 48 inches. Sheet separation is accomplished by timed suction cups used in conjunction with a continuous blast of filtered air, and by permanent magnets supplied for use when ferrous stock is being run. An automatic caliper actuates metal fingers which divert rejected sheets to a reject tray, while a latch-up device discontinues sheet flow without stopping the feed mechanism. In this way, double sheets can be prevented from reaching the fed machine without losing synchronization with the beginning of its operating cycle. The position of the pile can be adjusted by a manually operated shifter bar on the elevator in order to line up with the machine being fed. Pile height is automatically maintained so that the top sheet of the pile is always at exactly the right height for perfect feeding. A pile height governor which raises the elevator as sheets are fed off the pile provides pile height accuracy. Controllers and circuit switches are enclosed in a master panel mounted on the side of the feeder. Electrical equipment includes a constant speed air pump motor rated at 3 hp, a reversible elevator motor rated at 3 hp, an electric brake and clutch unit for the elevator, pile height governor, a remote control pushbutton station and suitable controllers for motors. Unit can be supplied with an independent drive or it can be driven by a power take-off from the fed machine. **Dexter Folder Co.,** Pearl River, N. Y.

Circle 403 on Inquiry Card



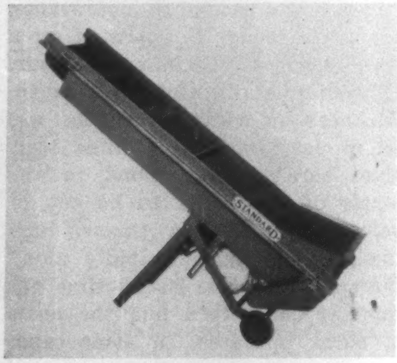
Labeling Machine

Designed for glue or thermoplastic labeling, fully automatic machine features flexibility in changeover from one size container to another. This change is accomplished in approximately 15 minutes and requires a minimum of interchangeable parts. Applying labels to flat, curved or recessed surfaces is done easily and the coating never comes out through the edges. This feature eliminates the need for wiping off excess adhesives. The machine handles any size and shape container from fractional ounce to gallons—in cardboard, tin, plastic, metal or glass. Labels from postage stamp size up to 6 by 6 inches can be applied. In operation, a vacuum finger takes the bottom label from the stack and delivers it to a moving member which grips 1/16-inch of the top of the label. It is then carried over the glue roller. Since there is no pressure exerted on the label, is absorbs only the amount of adhesive necessary. The coating is even and smooth at all times, assuring optimum adhesion to the container surface. Containers are held firmly on top and bottom after first being timed into the machine, permitting handling of odd shaped containers and assuring the container receiving the label is in register. Discharge arrangement is a rotating disk which can be attached to a conveyor to carry the labeled containers to further stations. Containers can be discharged at right angles or any desired angle. If the label stock is pregummed it is only necessary to use water or solvent in the glue chamber. Individual labels can be handled from conventional magazine or roll stock. Machine is equipped with a linear conveyor which brings the containers automatically under the hold-down pads. The containers are then moved intermittently and directly in front of the label application, then to two mechanical pressure pads for completion of labeling operation. **MRM Co. Inc.,** 191 Berry St., Brooklyn 11, N. Y.

Circle 404 on Inquiry Card

Parts Handler

Designed to handle stampings, die castings, plastic parts and pieces of all kinds from presses or other machines to tote boxes, bins or continuous conveyors, new conveyors are built in 4 ft 0 inch, 6 ft 0 inch, and 8 ft 0 inch lengths in three widths of 8, 12 and 16 inches. The conveyor can be set level at 18 to 31 inches or at slopes to 60 degrees. Belting is three-ply, 16-oz oil resistant rubber with 1½-inch high molded cleats at 24-inch centers, or three-ply 32-oz stitched canvas type with 1¼-inch steel angle cleats at 24-inch centers. Heavy duty metal belts are available for hot forge operations. Speed of the conveyor is 76 fpm, one way. Drive is a 1/3 hp gear head motor, single or three-phase with control switch and cord. Unit is of all steel type construction with slider beds, mounted on easily adjustable portable base with two 5-inch wheels. **Standard Conveyor Co.,** North St. Paul 9, Minn.



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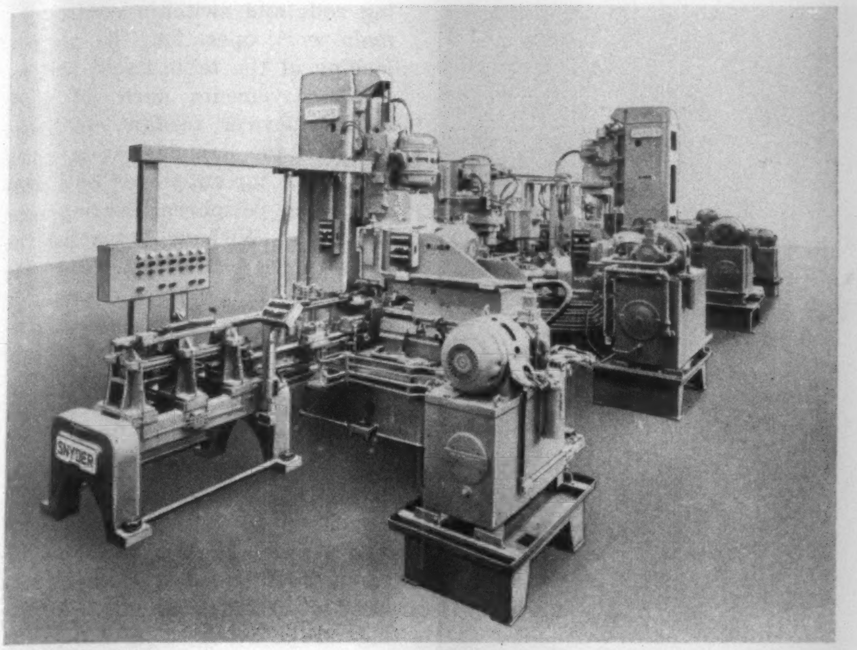
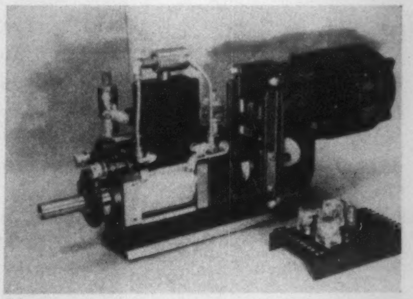


Processing Automotive Engine Exhaust Manifolds

Automotive engine exhaust manifolds are moved and oriented without the use of pallets in new segmented machine which features a twisted slide rail arrangement. The 2-station, 43-ft long machine performs all machining operations on the cast iron manifolds except the mounting faces, which are ground before the parts are loaded into the machine. Two bushings and two pins of different sizes are also hopper fed and assembled into the manifold by the machine which produces 106 manifolds per hour at 75 per cent efficiency. In-process gaging devices are included to assure through-drilling of tapped holes. In operation, the manifolds are loaded on slide rails on the ground faces and pushed from station to station on the rails. The parts are clamped in correct location in each machining station as they pass through the various machine segments. When the manifolds are half-way through the machine, the rails twist to tilt the parts 45 degrees for machining, thus avoiding auxiliary orienting devices. The segmented automation concept is applied in this machine which is made up of eight segments, each having separate bases and control panels. One master control panel provides the means for starting all the segments and stopping all the segments from one point. The segments are started in timed sequence to avoid excessive power surges. The timer control for a motor driven central lubrication system is in the master control panel as are the sequencing and safety interlocks for the index and initiation of cycle sequences of individual segments. **Snyder Tool & Engineering Co.,** 3400 E. Lafayette, Detroit 7, Mich.

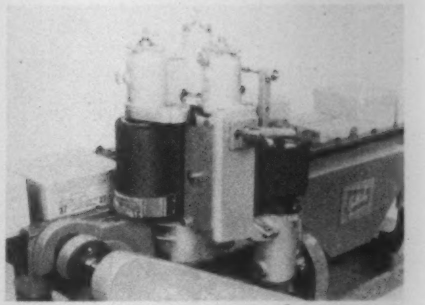
Circle 406 on Inquiry Card



Deep Hole Drilling

Attachment for standard drill unit converts machine into deep hole driller. Holes from approximately 0.025 to 5/8-in. diameter can be drilled in mild steel up to 3¾-in. deep. Positive acting hydraulic control of the spindle travel in both rapid and feed movements allows the drilling of work hardening materials such as stainless steel, as well as extremely soft materials such as copper. Length of rapid travel on the first advance stroke, the feed rate, the overall stroke length and the number of withdrawals per completed hole are all adjustable. The drilling action includes a progressive rapid approach to, but not touching, the end of the previously drilled hole. The drill advancement per step is a function of feed rate and time. The time is adjustable from 0 to 9 sec. and is established by an electronic type timer. The timer incorporates standard electronic components and all relays are of the plug-in type. The timer is available for panel mounting or can be obtained complete with its own dust-tight enclosure. **Hause Engineering,** Montpelier, O.

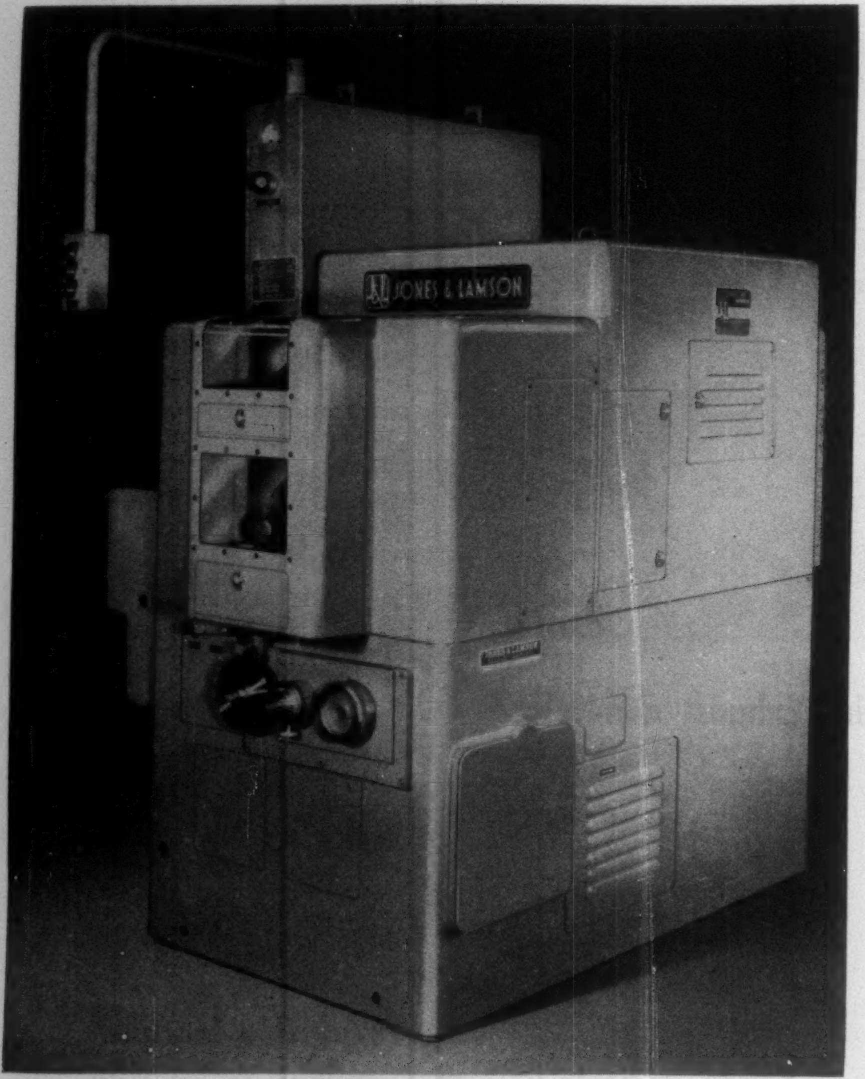
Circle 407 on Inquiry Card



Imprinting Machine

Designed for automatic, high-speed addressing of shipping cases, new imprinting machine accommodates quick-change printing dies and is adjustable for various sizes of cases. It is completely automatic and requires no attention except for changing address dies. Unit is designed to fill the need of quantity shippers for an efficient method of handling large numbers of the same size shipping cases destined for the same address. In application, cases ready for shipment to a single address are grouped together, and fed into the machine. The address is imprinted automatically on the cases and they are then discharged to a conveyor, pallet, tote box or basket. Address die is then changed and the next grouped shipment is fed through. In this way, large quantities of cases can be handled without confusion or delay. **Adolph Gottscho Inc.,** Hillside 5, N. J.

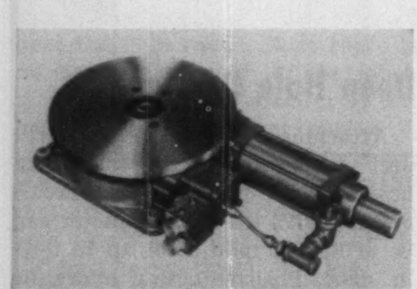
Circle 408 on Inquiry Card



High Production Tap Grinder

Equipped with automatic work handling, new machine is specifically designed for high production grinding of standard taps. Wide range of work speeds is available for effective grinding conditions on all tap sizes from 0 to ⅛-inch diameter. Individual lead screws for each pitch have ⅓ the pitch of thread being ground, insuring long lead screw life. Grinding cycles are held constant and uniform because rapid wheel advance, depths of cut and rapid withdrawal are positively controlled through simple cam action. Wheel truing is automatic before or after a finish cut and is counter controlled when more than one piece is ground per dressing. Wheel sizes are 16, 18 or 20 inches. Work and wheel slides are mounted on antifriction bearings. Wheel slide is held against a positive stop with uniform hydraulic pressure for automatic, positive size control. Machine has provision for multiple cuts. **Jones & Lamson Machine Co.,** Springfield, Vt.

Circle 409 on Inquiry Card



Rotary Indexing Table

Built-in automatic switch actuators are available in new air-powered rotary index table. Actuating rods and switches control the main work operation, the positive locking of the table itself, and related movements such as work holding devices, feeders, etc. Table has a 12-in. diameter, ¾-in. thick steel table top supported by a wide lubricated peripheral bearing near the edge. Without disturbing the table top, it can be set to provide 4, 6, 8, 12, or 24 stations. It can operate up to 150 index movements per minute, at the 24-station setting. Override or skipping of stations is impossible because the index cylinder piston seats against the cylinder head at the completion of any index movement. Loads up to 500 lb. can be carried without jarring, due to an adjustable air cushion device at the head of the index cylinder. A locking wedge actuated by a separate air cylinder provides positive repetitive stops within 0.002-in. at edge of table. A ⅝-in. inside diameter access hole is provided in the center post to permit passage of piping or wiring to the table top. **General Automation Products Co.,** P. O. Box 14, Birmingham, Mich.

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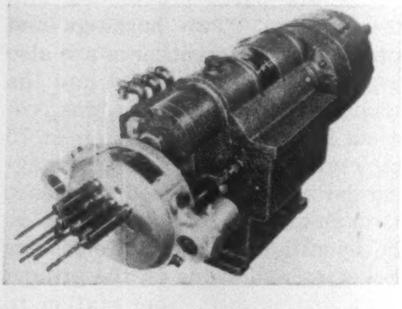


High Speed Drill Unit

Self-contained, high speed automatic drill unit has a drill capacity ranging from wire sizes to ½-inch in steel. An electric relay system controls the cycle and the drill depth. A hydraulic system controls the rate of spindle feed and prevents overtravel at the bottom of the spindle stroke. Drill depth can be set to less than 0.005-inch within the 3-inch maximum stroke. Rate of feed can be set from zero to the maximum the drill will stand. Air pressure, set to the drilling requirements, is used to

Plant engineers—here's two minutes *necessary* reading

G-E VOLTAGE STABILIZING TRANSFORMERS

TAKE THE LOSSES OUT OF YOUR PRODUCTION CYCLE

When you translate improper operation or equipment failure into terms of downtime and dollars lost, you come up with some very good reasons for stabilizing voltage. Conditions between source and load can cause voltage to vary as much as ten to fifteen percent. And in an automatic production cycle, varying voltage at the load seriously affects the operation of sensitive equipment. Thus, fluctuating voltage can cause improper operation of equipment or equipment failure.

Economical Voltage Stabilization

For most applications, voltage stabilizing transformers provide the most economical way to stabilize voltage at the load. The General Electric Company manufactures a complete line of these voltage stabilizing transformers which absorb the ups and downs of input voltage, and deliver stabilized output voltage to the load. Standard G-E voltage stabilizing transformers connected to an ordinary power-supply line can stabilize up to a 30% change of voltage to plus or minus 1% within 1½ cycles.

Automatic Voltage Stabilization

Stabilizing voltage with G-E voltage stabilizing transformers is completely automatic—no dials to set—no moving parts; no relays or tubes to cause maintenance problems. Simply connect the right G-E voltage stabilizing transformer on the line, and as the input varies, the output is held steady. Other features of these G-E voltage stabilizing transformers include: smaller size, reduced weight, primary-secondary isolation, built-in voltage transformation, rapid response, low stray-field intensity, wide input voltage range.

Before You Invest in Stabilizing Equipment

Unquestionably there are many ways to stabilize voltage. The type of stabilizing device that should be employed, of course, is the one that will provide the most economical stabilization to a satisfactory degree. That's why before you make *any* investment in more expensive voltage stabilizing equipment, make certain you investigate General Electric voltage stabilizing transformers by contacting your local General Electric Apparatus Sales Office or distributor. Or send for a special bulletin on G-E voltage stabilizing transformers by mailing the coupon below. General Electric Company, Schenectady 5, N. Y.

Send for Free, Illustrated Bulletin!

Section A410-24
General Electric Company
Schenectady 5, N. Y.

Please send me GEA-5754B, Voltage Stabilizing Transformers

NAME..

COMPANY..

STREET..

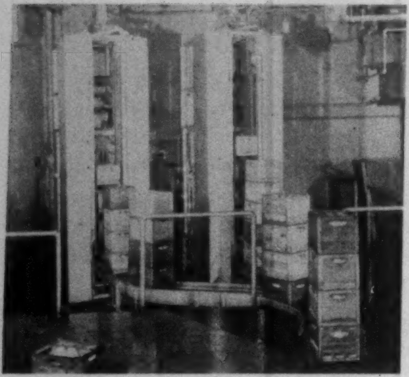
CITY.............................. **ZONE**........ **STATE**..........

GENERAL ELECTRIC

Circle 581 on Inquiry Card

feed the spindle forward and to return it to its starting position. The spindle drive is supplied by either a direct mounted motor or by a pulley shaft assembly. Since the spindle feed and return is air actuated through two hardened and ground power rods, the spindle assembly and the drive unit are not subject to forward, end or side thrusts. This feature plus the wide spacing of the power rods assure rigidity and accuracy. Other features of the drill unit include rapid approach and retract of the spindle and automatic return of the spindle in the event of a power failure. Units, combined with multiple heads and electrically synchronized indexing fixtures, can be mounted on a standard machine base to meet special drilling requirements. **Ettco Tool Co. Inc.,** 594 Johnson Ave., Brooklyn 37, N. Y.

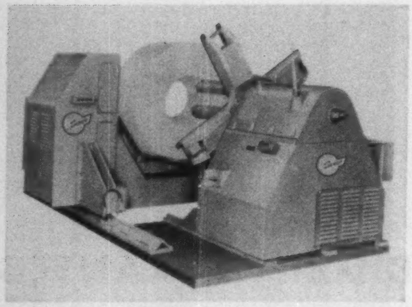
Circle 411 on Inquiry Card



Case Stacker

Designed to speed up any operation where wood and metal cases, wire baskets or cartons are used, automatic case stacker is capable of handling up to 24 tons of cases per hour, stacking them three to six high as required. First introduced in dairies, the case stacker proved a cost saver in time and labor. Smooth, gentle stacking assures less damage to cases and their contents. Machine is available in two models; one unit stacks from the bottom, the other from the top to accommodate cases from an overhead or second floor conveyor down to lower floor-type conveyor. **Mojonnier Bros. Co.,** 4601 W. Ohio St., Chicago 44, Ill.

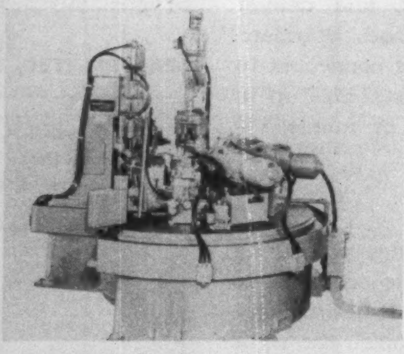
Circle 412 on Inquiry Card



Coil Loader

Designed to load centering reels, new power lift coil loader reduces downtime for reloading coil stock. Compact design of the loader eliminates the necessity of a pit. Lateral movement is easily obtained for the lift loader as it is mounted on rails, permitting freedom for loading of coil. The coil is elevated to obtain core alignment and then is transferred laterally to the expander arms of the centering reel. Complete movement of the coil, both lateral and vertical, is by electrical power and is pushbutton controlled. Illustrated model is designed for loading a single coil. Lift loader can be built to handle multiple coils and to specifications to handle coil weights up to 40,000 lb. **Sesco Inc.,** 8881 Central Ave., Detroit 4, Mich.

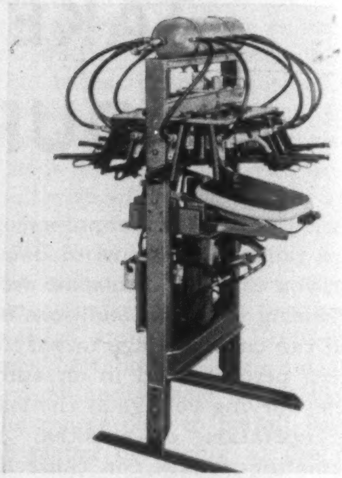
Circle 413 on Inquiry Card



Shaft Driller and Miller

Twelve-station horizontal indexing drilling and milling machine is used to drill, tap, slot, straddle mill and broach nine different brass throttle shafts. Five cam feed drill units, one lead screw tapping unit and one air operated broach are used to process the parts. Four drill units with milling attachments are mounted horizontally; one is mounted vertically. The lead screw tapping unit is mounted vertically. Parts are loaded in a vee-block with hand screw clamp and automatically indexed through the processing cycle. Production at 100 per cent efficiency is 600 parts per hour. **Hartford Special Machinery Co., Machine Tool Div.,** 285 Homestead Ave., Hartford 12, Conn.

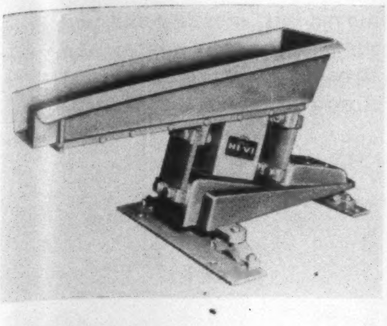
Circle 414 on Inquiry Card



Tacking Machine

Combination electric and pneumatic tacking machine provides automation in staple tacking. Illustrated model fastens the cardboard bottom to a chair seat with 12 staples which are driven simultaneously. In operation, the chair seat is placed on a platform which trips an electric switch, causing the pneumatic system to start working. Air lifts the platform upward until the chair seat touches the noses of the air tackers mounted above. The tackers then simultaneously drive 12 staples which are perfectly positioned. After the tacking operation is completed, the electrical system again takes over, tilting the platform so that the finished seat slides off onto a conveyor. As this takes place, another switch is tripped, causing the machine to return to its original position, ready for the next seat. The entire cycle consumes approximately 3 seconds. New tacking machines are custom designed to the particular requirements of the job to be performed. **Fastener Corp.,** 860 Fletcher, Chicago 14, Ill.

Circle 415 on Inquiry Card



Vibratory Feeder

Designed for adaptability in such materials handling operations as feeding, mixing, drying, cooling, packing, conveying and spreading, new vibratory feeder units can handle a variety of bulk materials ranging from big pieces of stones, coal, etc. down to fine powders. The units have many applications, including feeding enclosed furnaces; feeding material to be aerated, cooled or dried; feeding materials that require sizing, grading, mixing or blending; feeding materials where accurate rate of flow is required; and feeding bulk materials to packaging operations. Flexible control of the feed rate is obtainable with the use of a remote controller which contains no high maintenance rectifier, merely a rheostat to vary the voltage across the unit. Enclosed drive element in the feeder combines an electromagnet with a permanent magnetic armature, utilizing the principle of magnetic attraction and repulsion between magnetic poles that are constant in the permanent magnet and alternating in the electro to set up a rapid oscillation of the armature, powered on both strokes. To this is added the driving force of the energy stored in the two steel springs between which the drive element is mounted. Magnetic system acts to alternately pull down and back, and then push up and forward on a tray assembly. Magnets are assisted in this motion by the spring mountings. As the tray is pulled down and back, the material in the tray falls vertically to a new position forward in the tray. Three models of the feeder are available, designated as FE-2, FE-4, and FE-10, according to their respective ability to move two, four, or ten tons of dry sand per hour in normal operation. **Eriez Mfg. Co.**, Erie 6, Pa.

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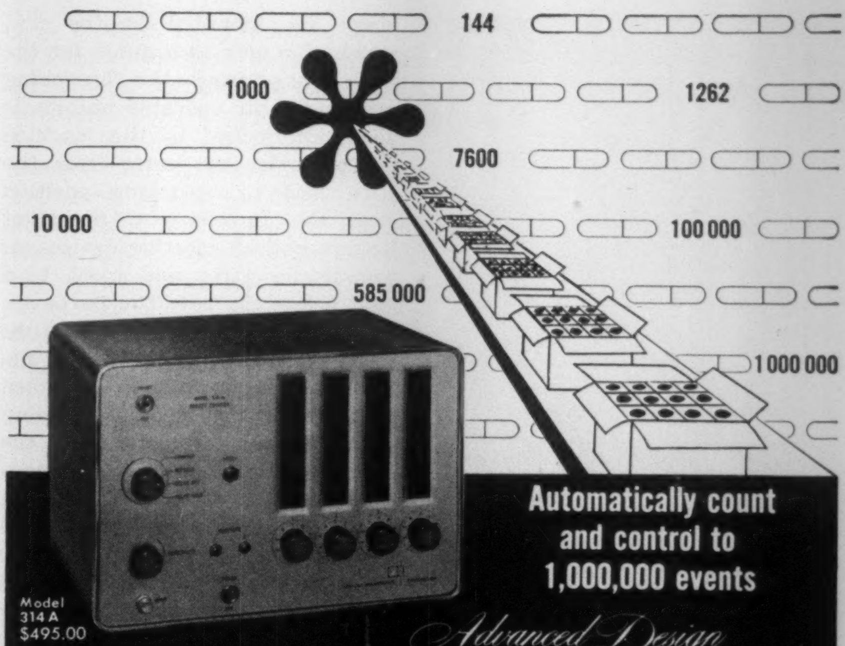


ELECTRONIC PRESET CONTROLLER

The CMC Model 310 Series Preset Controllers are designed as high speed direct reading electronic counters of the coincident type which will control any operation or activate an alarm after a preselected total count has been reached.

***A few of the many applications are batching and packaging of pills, bottles, bottle caps, canned goods, pen points, machine parts, electronic components, etc., in exact preselected quantities; controlling the exact length of stock in cutting operations; and control of high speed machinery.** Any electrical, mechanical or optical events which can be converted into electrical impulses can be counted and controlled. Devices to effect this conversion may be photocells, magnetic coils, switches, and suitable transducers for pressure, temperature, velocity, acceleration, displacement, etc.

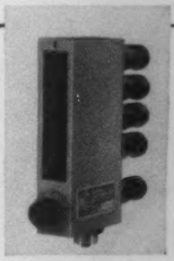
SPECIFICATIONS

	312A	313A	314A	315A	316A
Decades	2	3	4	5	6
Count Capacity	100	1000	10,000	100,000	1,000,000
Counts per Second	0 to 100,000 (as totalizing counter)				
Recycling Rate	50,000 counts per second (as preset counter)				
Input Sensitivity	0.05 volts rms: 10-100,000 cps 0.07 volts rms: 1-10 cps Positive Pulse Rise Time: ½ volt or more per sec.				
Input Impedance	0.5 megohm, 50 mmf				
Accuracy	Absolute				
Output	60 volt positive pulse, 10 microseconds duration (negative pulse optional)				
Output Relay Contacts	5 amps, 117 volts, non-inductive load Normally open or normally closed (with indicator lamps) Can be switched out				
Relay Hold Time	Automatic: Continuously variable from 0.1 to 1 second Manual: Lock until release				
Auxiliary Power	6.3 volts ac @ 3 amps; +225 volts dc regulated @ 50 ma; —150 volts dc regulated @ 5 ma.				
Power Requirements	117 volts ± 10% 50-60 cycles 100-150 watts depending on model				
Dimensions	13" W x 8¾" H x 13" D			16¼" x 8¾" x 13"	
Net Weight	20 to 28 lbs. depending on model				
Finish	Panel: Light grey baked enamel Case: Dark grey baked enamel				
Data Subject to Change Without Notice					

FEATURES

COINCIDENT TYPE
ABSOLUTE ACCURACY
DIRECT SETTING
DIRECT READ-OUT
EXCEPTIONAL VERSATILITY
HIGH SPEED
RELIABLE
RUGGED
ECONOMICAL
SMALL SIZE

The direct reading Model 101A Preset Decade Counting Unit is designed to provide an output pulse at a selected number at rates in excess of 50,000 counts per second. They are capable of counting at a 100,000 cps rate if reset is not required. These units are readily connected in cascade in order to emit a pulse at any desired count. Typical applications are batching, sorting, packaging, automatic counting and control, frequency division, generation of precise delays, etc.



Model 101A $75.00

CMC

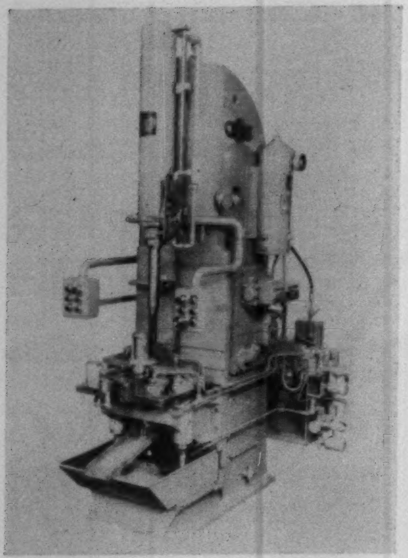
Write for complete catalog and prices.

Computer-Measurements Corporation

5528 Vineland Avenue, North Hollywood, Calif. Dept. 95-F

JC-14

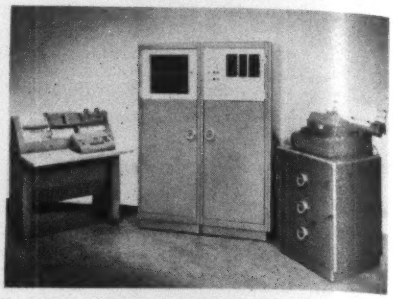
Circle 582 on Inquiry Card



Continuous Cycle Press

Hydraulic press with continuous automatic cycle broaches 30 external involute gear teeth on the outside diameter of a bronze automotive synchronizer ring. Broaches for the machine are mounted in a stationary broach pot, through which the part is pushed. Ten involute spline broach rings are mounted in the pot, which also acts as a guide for the push bar during the broaching stroke. An air operated automatic slide, interlocked to the machine cycle, carries the parts from the tube feed to broaching position over the broach pot. Stripping fingers and an ejection device automatically strip and eject the part below the pot. The parts are fed to the slide by a gravity tube feed. A single spline inside the tube radially locates the notched parts. With the machine running on continuous automatic cycle, the operator only has to keep the magazine feeding the slide filled with parts. Parts are placed in the tube feed indexed by the spline. The slide picks up a part from the tube and moves it into broaching position. The ram moves the push bar down, pushing the part through the broach pot, broaching 30 involute gear teeth on the outside diameter. At the end of the broaching stroke, the stripper fingers move in between the part and the broach pot, stripping the part from the push bar which is returned by the ram. A plunger then moves out, ejecting the part down the discharge chute. **American Broach & Machine Co.,** 415 W. Huron St., Ann Arbor, Mich.

Circle 417 on Inquiry Card



Chemical Data Handling

Designed for use in the chemical and process industries, versatile data handling system offers ease of operation, accuracy and reliability. New electronic system reduces time required for recording temperatures, pressures, flows and other physical variables for a plant processing stream, such as in a petroleum refinery. New system can be used in a variety of pilot plant studies to develop im-

Here is an IMPORTANT conveyor message for the metalworking industry

Write today for complete information.

MAY-FRAN

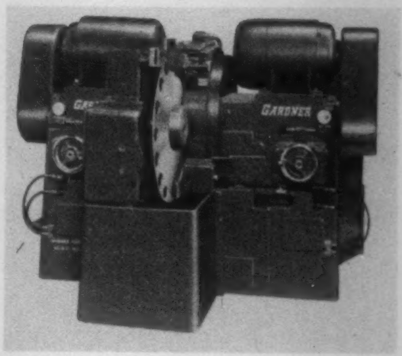
ENGINEERING, INC.

1761 Clarkstone Road Cleveland 12, Ohio

proved production techniques and as a component in a fully automatic plant. Versatility is achieved through the use of the pinboard programmer by which the system can be applied to a variety of chemical and petrochemical processes and permits quick adaptation of the system to changes in the specific data handling requirements. Easy digital control over the many system functions such as scaling, zero offset, linearizing, alarm limits, totalizing and readout is accomplished through the programmer. These operations can be performed on as many as 1000 different inputs from sensing instruments along the plant stream. An analog to digital converter performs the mathematical functions necessary to transform the electrical measurements into numerical form. Performance data from the system is logged out on paper tape, punched cards or on automatic typewriters. Two typewriters are provided with the system —one for logging and the other for alarm. The logging typewriter will print out information from all channels at selected intervals of 3, 6, 15, 30 or 60 minutes. When an alarm condition is detected, a signal is provided which may show an alarm light or ring a bell. At the same time, the time, channel number and data are printed on the alarm typewriter in red. Advantages of the separate alarm typewriter include adequate spacing for printing, allowance for trend recording of all out-of-limits data, reduced duty requirements of logging typewriter, etc. **Beckman Div., Beckman Instruments Inc.,** Fullerton, Calif.

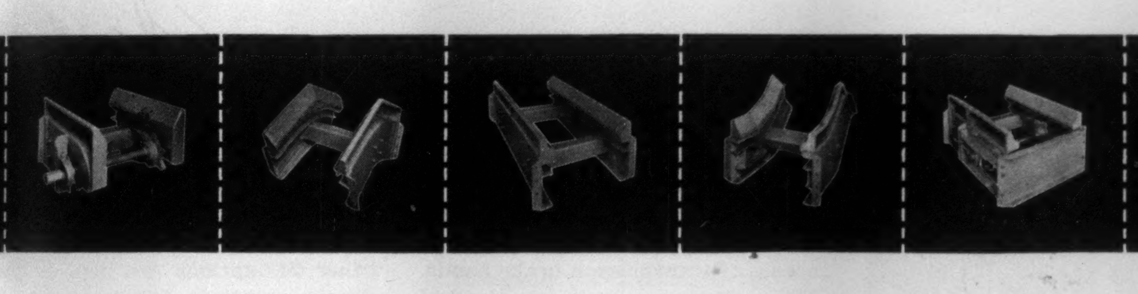
Circle 418 on Inquiry Card

Double Spindle Grinder



Designed for work in bearing, automotive, electrical, ceramic, machinery and similar industries, new machine grinds two parallel surfaces in one operation. Grinder features new spindle design which increases rigidity 500 per cent at the rim of 30-inch diameter disk. Ways are proportioned for increased stability of grinding heads. Tilt and swivel provisions with head zeroing indicator simplify disk alignment. Coolant tank is an integral part of the machine bed. In mass production operations, with through-feed fixtures or rotary work carriers, continuous and high production is possible. Easier operation is afforded with greater accuracy through improved disk feed. Feed increments of 0.0001-inch are possible. Easier and faster disk change reduces downtime and increases production time. Less maintenance is required because of permanently lubricated, preloaded and sealed spindle bearings. Centralized lubrication system for ball bearing ways and feed screws is provided. **Gardner Machine Co.,** Beloit, Wis.

Circle 419 on Inquiry Card



NOW YOU CAN ASSEMBLE YOUR OWN "CUSTOMIZED" CONVEYORS FROM PRE-FABRICATED STANDARD SECTIONS.

If your plant produces stampings, formed metal parts, castings or forgings . . . if you have a byproduct such as automotive scrap, chips and turnings . . . the MAY-FRAN conveyor standardization program will provide your company with savings never before possible.

Through standardization, MAY-FRAN now makes it possible to assemble individual components into virtually any type of conveyor to handle a wide range of products or materials. Straight sections . . . concave or convex sections . . . take-up charge sections and discharge-end sections can be furnished to meet specific requirements of belt width as well as load bearing and volume capacities.

Even after they are installed, MAY-FRAN conveyors can be dis-assembled and re-assembled in other plant locations . . . to handle other products. Standardized conveyors can be lengthened, shortened or modified in almost any way . . . and at minimum cost.

Pre-fabricated conveyor sections can be furnished rapidly and inexpensively. The individual components provide users with the ultimate in flexibility. MAY-FRAN hinged-steel conveyor belting is used on the Standardized units. Belting is available in widths from 6 inches to 6 feet in any length. Solid and perforated links are available in pitch lengths from 2½ to 9 inches.

MAY-FRAN . . . a name long recognized in the materials handling field . . . is first again with standardized components for your customized installations.

6830-MP

Circle 583 on Inquiry Card

a complete line of
Printed Circuit Hardware
and
Terminal Inserting Equipment

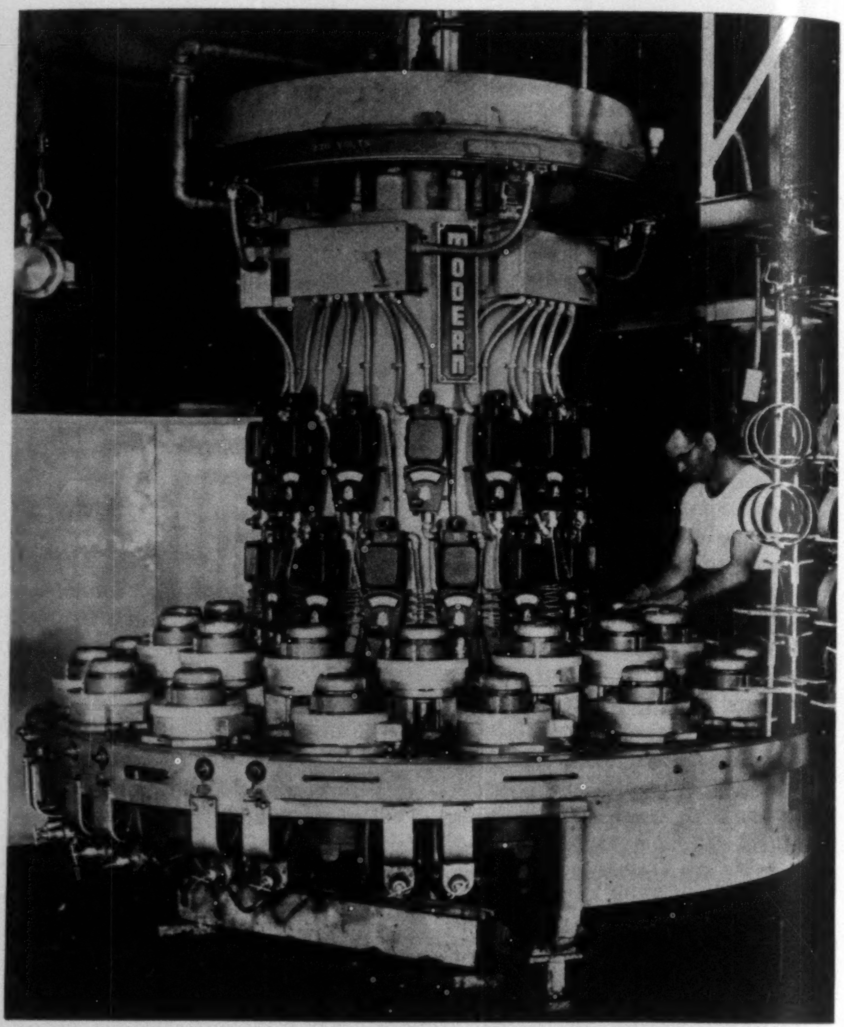
Tubular Pin Terminals—Insert automatically into printed circuit board at huge production savings. Snap into position with positive locking action by means of self-retaining snap-in feature. Double ends permit wrapping or inserting leads at either end. Ask for Bulletins 550 and 551.

Solderless Wire Disconnect Female Terminals—Speedily applied to leads by means of cost-saving automatic equipment. Fits quickly and firmly to tubular pin terminals. Solderless wire crimp can be varied to fit various size insulated wires. Ask for Bulletin 553.

Line Cord Interlock Terminals—For single or multiple lead connections. Another Malco automation development to provide production short cuts and assembly economy. Terminals are staked quickly and firmly into printed circuit boards. Ask for Bulletin 554.

Malco printed circuit hardware can be engineered to your specific requirements. Give us the facts about your operation. We'll show you how your costs can be lowered and your production increased. Ask for Bulletin 551.

Malco TOOL and MANUFACTURING CO.
4017 W. Lake St., Chicago 24, Ill.
Circle 584 on Inquiry Card



Transmission-Band Bonding Machine

New 30-station rotating machine makes possible high output of bonded automatic transmission bands. Machine handles two thicknesses of transmission brake bands. Time cycles as well as mandrel pressure and temperatures can be varied depending on the thickness of the metal band on the part being bonded. In bonding the transmission brake band with the thicker metal band, a part makes the complete cycle in 10 minutes giving a production rate of 180 per hour. Parts with the thinner bands take 7½-minutes for a complete cycle with output totaling 240 parts per hour. Machine uses regular plant air supply at 90 psi for clamping parts during the bonding operation. An air regulator valve is provided for each station to control uniformity of pressure and each station also has its individual adjustable temperature control. Five control panels are provided, each handling six work stations. In this way a group of six stations can be taken out of service for repairs or maintenance while the other 24 stations are kept in production without interruption. In operation, adhesive coated molded brake band linings are placed into metal bands for bonding and put on segmented mandrel by operator at the start of the cycle. Air pressure applied through a cylinder at each work station forces jaws apart holding the lining to the metal band under heat and pressure. As machine rotates, cam on the outer periphery of machine releases pressure temporarily allowing gases to escape and insuring a complete bond. At the completion of cam travel the pressure is reapplied for remainder of bonding operation. For curing with the thicker band, 185 to 200 psi pressure at 435 to 450 F is applied for 10 minutes. The thinner band requires

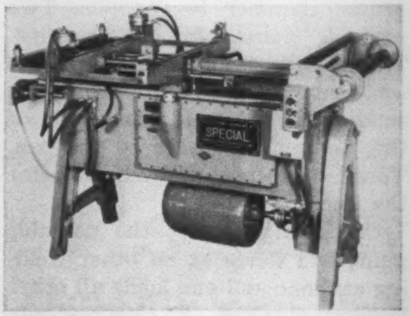
125 to 135 psi at 400 to 415 F. Pressures at each work station are set by means of a gaging unit. **Modern Industrial Engineering Co.,** 14230 Birwood Ave., Detroit, Mich.

Circle 420 on Inquiry Card

Electronic Piston Gage

New unit which measures taper and outside diameter on automobile pistons and then stamps a code letter on the piston to identify the diameter is semiautomatic in operation. The gaging and stamping action of the electronic gage is entirely automatic, but the parts are hand fed and hand removed. Gages with fully automatic feeding and sorting units are available. New gage takes both measurements—taper between top and the bottom of the piston skirt and the outside diameter at the upper end of the skirt—simultaneously. If the taper measurement is not within tolerance limits, the electronic classifier of the gage will ignore the diameter measurement and the part is rejected. If the taper is satisfactory, it can be assigned to any one of six good diameter classifications differing by 0.0003-inch; other categories are oversize and undersize. Signal lights for each diameter classification enable the operator to see quickly in which category a piston belongs, and an ink impregnated stamper unit stamps the code letter indicating the diameter on the piston itself. Use of a gage such as Model 144 B-83, which stamps the diameter code indelibly on the part, can reduce both assembly time and assembly errors. With this model, the operator places a piston on a precision ground locating plug which assures positive centralization of the part in the gage. After the part is located properly, a switch is tripped which starts a vibrator that settles the part firmly between the gaging contacts. Both the taper and diameter measurements are made simultaneously and the electronic classifier receives the size signals from the gage heads. The classifier lights the proper signal light and activates the stamper unit. When the piston is released by the stamper, the operator places it in the disposal box as indicated by the signal light. The gaging cycle takes approximately 4½ seconds. **Federal Products Corp.,** 1144 Eddy St., Providence 1, R. I.

Circle 421 on Inquiry Card



Punch Press Feed

Designed for automatic feeding of coiled stock, hydraulic gripper type punch press feed handles stock up to 36 inches wide by 3/16-inch thick for feed lengths up to 36 inches long. All models are adjustable to take narrow width stock, and for feed stroke length from zero to the maximum of the unit. Feed stroke is adjusted by a small hand wheel; adjustment can be performed while unit is operating. Limit switch mounted on the press and actuated by any moving part of the press or die timed with the ram, energizes a solenoid which starts the feeding cycle. Stock is fed on the up stroke of the press. **Special Engineering Service Inc.,** 8161 Livernois, Detroit 4, Mich.

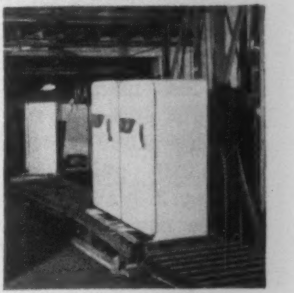
Circle 422 on Inquiry Card

SPEED UP
"Between-Floors"
CONVEYOR LINES

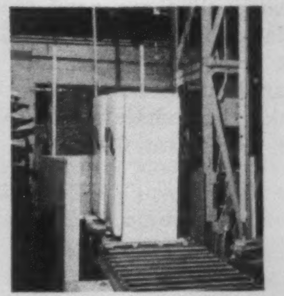
Weld-Bilt
Automatic
"VERTICAL
TRANSPORTATION"

Weld-Bilt Floor-to-Floor Elevators are designed to improve your conveyorizing between two or three floor levels. Highly versatile in application, they provide completely automatic loading, unloading, lifting or lowering — with limit controls, brakes, inclinable or mechanical platforms, selector push buttons in any combination to suit your product and conveyor systems.

TYPICAL WELD-BILT
"VERTICAL TRANSPORTATION"



Freezers automatically conveyed to elevator on top floor. Freezer weight trips controls to start descent.



Roller platform automatically tilts at lower level to discharge freezers to conveyor. Load release starts elevator ascent to top floor.

If your production flow can benefit by floor-to-floor conveyorizing, write for suggestions on Weld-Bilt "Vertical Transportation."

"Weld-Bilt" PRODUCTS

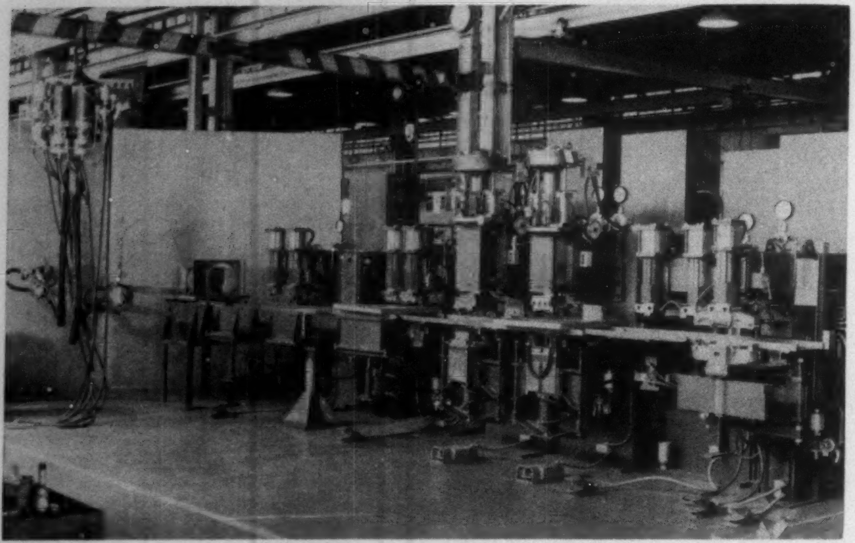
Weld-Bilt Automatic Conveyor-Lifts Elevators, Portable Elevators, Drum Elevators, Lift Trucks, Pallet Trucks, Hydraulic Lift Tables, Skid Platforms, Special Equipment.

SEE OUR EXHIBIT MATERIALS HANDLING SHOW — JUNE 5-8 —BOOTHS 210-212-309-311.

WEST BEND EQUIPMENT CORP.
MATERIALS HANDLING ENGINEERS

347 WEST WATER STREET • WEST BEND, WIS.

Circle 585 on Inquiry Card

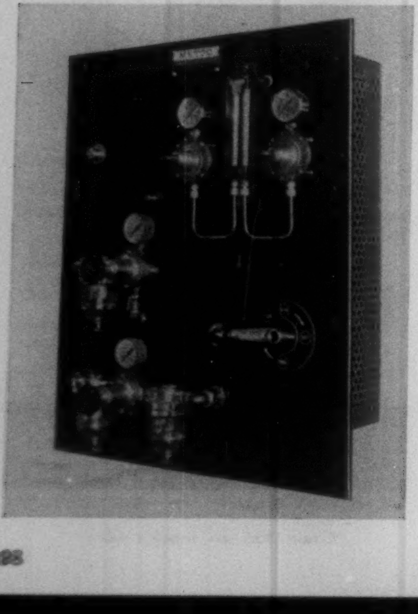


Resistance Welding Line for Air Conditioning Units

Economical method of manufacturing air conditioning units is provided by resistance welding line. Adaption of standard welders for producing both ¾ and 1 hp size units results in more production with less manpower. Machine at the right performs two operations: Welding 0.040 galvanized handle to 0.080 galvanized pan and welding 2 1/16-inch screen on the pan to cover the intake opening. The second machine welds four 0.040 galvanized clips to the pan in one operation. The two upper clips are used to retain the cover, and two inside clips are used to retain insulation. The third machine welds 0.080 galvanized motor mounting bracket to the pan. In one stroke the fourth machine on the line welds two 0.110 galvanized compressor mounting brackets to the pan. The next machine, in one stroke, welds 0.040 galvanized evaporator scroll partition to the pan. The final machine welds 0.040 galvanized plenum condenser chamber to the pan. Two portable guns complete the line. The large gun welds 0.040 galvanized stabilizer clip to the scroll; the small gun spot welds each side of the plenum condenser to the pan. Three operators are required for the line.

One man operates the portable guns, one welds at all other welding stations and one loads all other loading stations. Production rate of the line is 72 units per hour. **Sciaky Bros Inc.**, 4915 W. 67th St., Chicago, Ill.

Circle 423 on Inquiry Card



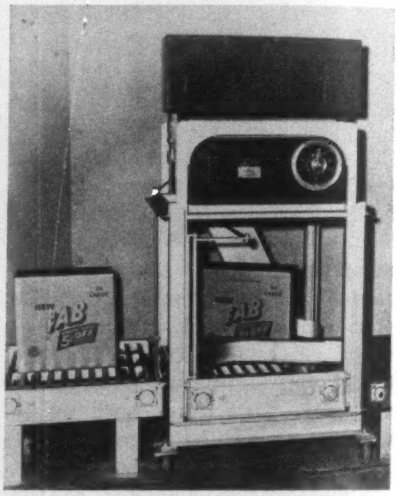
Automatic Metal Spraying

Completely automatic metallizing production line is possible with new control panel. Unit can be set for all gas, oxygen, and air controls and wire feed. Operator stops and starts the spraying operations with a turn of the control handle. The control panel automatically opens gas valves, lights gun and starts wire feed. Without disturbing any adjustments, the operator can light, run, stop and relight as often as the production run requires. **Metallizing Engineering Co. Inc.**, Westbury, N. Y.

Circle 424 on Inquiry Card

Checkweighing Scale

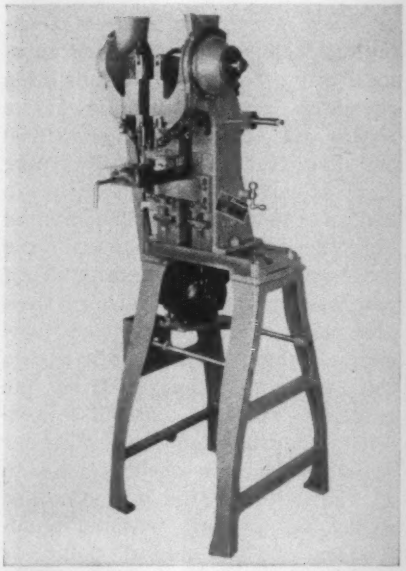
Designed for handling cartons, bags and drums, fully automatic checkweighing scale may be installed in an existing conveyor line. It may be used to indicate the exact weight of each package which goes over the scale conveyor platform and to reject automatically those packages which are underfilled or overfilled. Model 200SR automatic scale is furnished with a motor-driven conveyor which is suspended from a plate scale leverage system. The patented plate system of scale platform, lever and weigh-beam suspension does not use knife-edge pivots, thus reducing wear. Plate leverage system retains its original accuracy and sensitivity, and is well suited for use in locations where dusty, abrasive and corrosive materials are being handled. Electrical relays and controls for the operating mechanism are contained on a control box which may be remotely mounted. The scale is furnished with a register which indicates the exact weight of the package, a counter which counts the number of packages, and with a dial which indicates the exact weight the package is over or under the prescribed limit. A weight indicating dial is also furnished; this device may be mounted remotely at the package filling station. Scale is available with controls for adjusting the overweight and underweight tolerances. Controls are also furnished for interlocking with existing conveyors and material handling systems. Optional feature is the automatic



printing recorder which prints the exact weight of the package on a roll of paper. Model 200SR can be used for handling various size packages ranging from 10 to 200 lb. It can be furnished with an automatic compensator mechanism for adjusting filling machines. When the checkweight scale detects overweight or underweight packages, it will send an electrical impulse to the package filling machine to correct the amount of product entering the packages. **Thayer Scale & Engineering Corp.,** Rockland, Mass.

Circle 425 on Inquiry Card

Double Rivet Setter

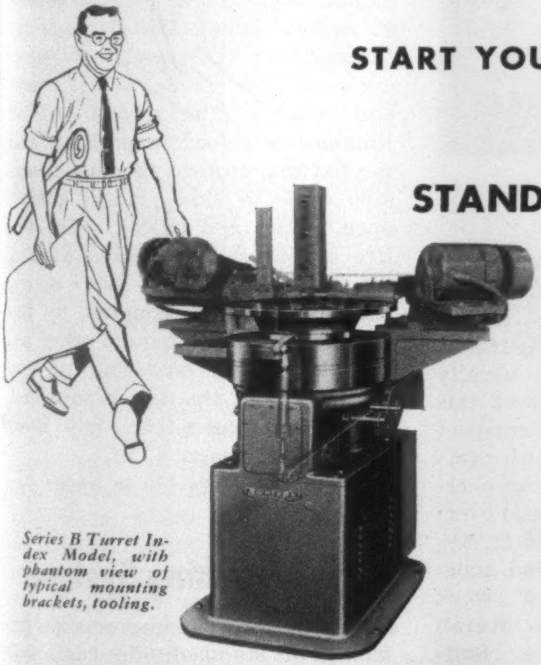


Combination machine and fixture permit setting two rivets at a time in a variety of assemblies. Flexibility of machine is increased by the design which includes a quick-change type of hopper raceway unit—a means of replacing the feeding mechanism when changing sizes of the rivets. Two rivets can be fed, inserted and upset with each release of the foot pedal. A nonrepeating clutch is provided for safety of operation. One riveter is bolted solidly to the base; other may be moved by means of a ball crank to establish the desired center. Rivets can be set as close as 7/16-inch, or as far apart as 6 inches. Illustrated machine provides a means whereby the work can be loaded forward of riveting position for safety, slid into riveting position and have the machine automatically trip when in that riveting position. Operation is achieved by means of a limit switch mounted at the back of the fixture; tripping operation such as this is done when used with dial fixtures, line fixtures and other forms of continuous action conveyor units. Machine is furnished either as part of automation equipment or can be integrated into the manufacturer's automation line. **Chicago Rivet & Machine Co.,** 9600 W. Jackson Blvd., Bellwood, Ill..

Circle 426 on Inquiry Card

Business Machine

Developed to simplify inventory and material control, production requirements planning, production scheduling, production control, job order cost accounting, sales analysis and control, and similar business functions, new business machine is called the Series F Magnefile. The machine performs accounting functions electronically. It permits direct posting from accounting department forms onto a simplified keyboard and requires no special forms, cards, sorting or



START YOUR AUTOMATION PLANNING WITH
SWANSON
STANDARD INDEXING MACHINE CHASSIS

Save valuable engineering time and cut the cost of building your automatic and special purpose machines

You can get the benefits of automation *without making a large capital expenditure.* You can easily justify automation projects by building your special machinery around a Swanson standard chassis.

These versatile "packaged" units provide the basic chassis for a wide range of special purpose automatic machines. Because they eliminate much of the engineering and building formerly required, Swanson units lower costs and shorten completion time . . . considerably broadening the applications of automation.

Series B Turret Index Model, with phantom view of typical mounting brackets, tooling.

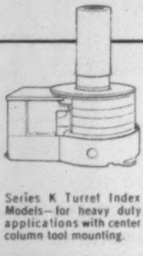
Write for Bulletin 356-A. It describes the complete line of Swanson Standard Index Machine Chassis.

SWANSON
TOOL & MACHINE PRODUCTS, INC. • ERIE, PA.

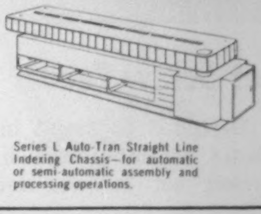
ENGINEERS AND BUILDERS OF AUTOMATIC AND SPECIAL PURPOSE MACHINES SINCE 1919

Series B & C Turret Index Models—for medium and light applications

Series H Turret Index Models—for heavy duty applications.

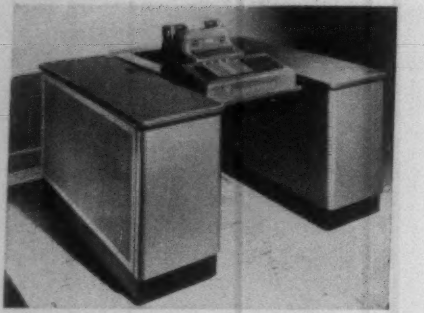


Series K Turret Index Models—for heavy duty applications with center column tool mounting.



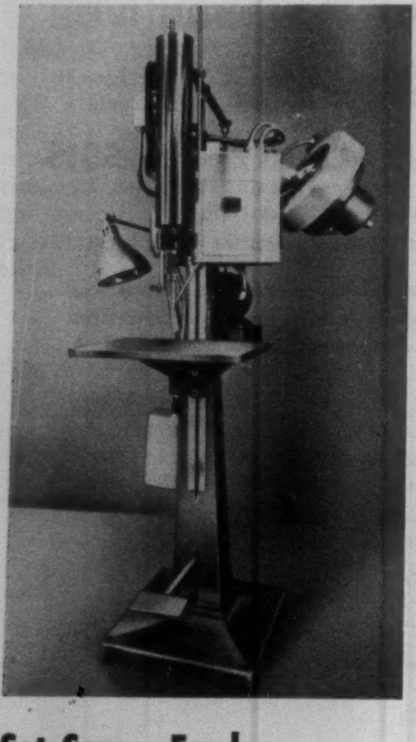
Series L Auto-Tran Straight Line Indexing Chassis—for automatic or semi-automatic assembly and processing operations.

Circle 586 on Inquiry Card



coding. Information from these entry transactions is automatically computed by addition to, or subtraction from previous balances on record and stored internally. When the status of a particular item or group of items is required, it is automatically recorded onto continuous form paper by the typewriter-printer, eliminating the need for reference reports. Magnefile combines the simplicity of a standard office machine with the high speed and large data processing capacity of an electronic computer. **Electronics Corp. of America, Business Machines Div.,** 30 Rockefeller Plaza, New York 20, N. Y.

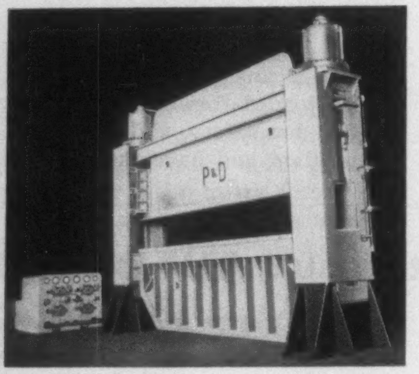
Circle 427 on Inquiry Card



Set Screw Feeder

Designed to assist in the automatic assembly and insertion of socket set screws, new machine provides automatic hopper feeding. Socket set screw feeder automatically feeds and positions standard hex or multiple spline socket set screws, and gives 100 per cent feed to automatic power screwdrivers. Feed rates up to 2700 per hour are possible, limited only by the rate at which the screwdriver can be operated. Unit can feed socket set screws of various sizes, with moderate adjustments. Finger adjustments enable the operator to switch from one length to another, while it is necessary only to change a few feeder tubes to go from one diameter to another. Screws fed are standard socket set screws, without modification of lead thread, point, or socket end. **Bristol Co.,** Waterbury 20, Conn.

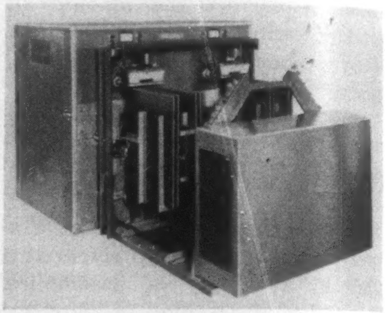
Circle 428 on Inquiry Card



Hydraulic Press

Furnished with completely automatic and extremely sensitive ram leveling device as well as a ram tilt feature, 1000-ton hydraulic press offers features not usually found in heavy machinery of this type. Unit is extremely compact in relation to its rating, with overall length of 26 ft, 1 inch; overall width of 4 ft, 6 inches and overall height from floor of 16 ft, 5½ inches. Completely open end housings permit passage of work through the press, up to overall length of pressing surface. Suitable for straight-through feeding of work, unit is adaptable to many pressing operations such as forming, blanking, bending, straightening and drawing. Four different ram speeds can be provided, with a wide adaptation of working cycles. Heavy steel plate up to ⅞-inch thick by 19 inches long can be processed. When ram unit reaches approximately ¼ of tonnage capacity, it will automatically slow down the pressing speed. Various other models of press are available, ranging in capacities from 500 to 2000 tons, and lengths from 6 to 30 ft. **Philips & Davies Inc.,** Kenton, O.

Circle 429 on Inquiry Card



Induction Generator

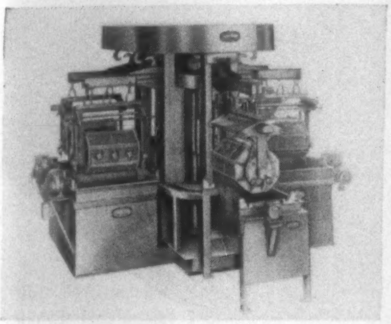
Hinge-pin thimbles are silver soldered to opposite ends of refrigerator and freezer doors by induction generator and fixture. Device uses a 5 kw., two-station generator, with automatic tooling to handle four doors simultaneously at each station. The fixtures go through an automatic five-step cycle to close, index, solder, open and rotate. The second set of thimbles is placed in position and the fixtures proceed through a six-step cycle to close, index, solder, open, rotate and unlock. The entire cycling process takes 44 sec. for each group of four doors. Equipment can be adapted, by fixture variations, to handle other assemblies where soldering of opposite ends of the unit is involved. **Reeve Electronics Inc.,** 609 West Lake St., Chicago 6, Ill.

Circle 430 on Inquiry Card

Barrel Finishing Systems

Designed for microprecision finishing of stamped, die cast, machined, extruded and centerless ground parts, new barrel finishing systems are completely automatic, controlled by one operator and preset switches. Finishing operations performed in this system can include: Descaling, degreasing, grinding, deburring, burnishing, rinsing and rust inhibiting of metal parts.

Two types are available: Skip-station type and in-line type. The former system can simultaneously finish a variety of parts requiring different finishes by automatic programming feature. The in-line system is particularly suitable for finishing high production parts of different types requiring the same finishes and processes. Feature of these automated systems is the materials handling system—even delicate centerless ground steel parts can be handled throughout the system without part on part impingement. In unloading, the parts and abrasive media are emptied from the barrel to a belt conveyor; parts are then separated from the media by a magnetic separator and then pass through drier unit to a pick-off table for assembly or storage. The media drop into a vertical bucket elevator and are raised to an overhead rotary screen classifier. At this point the different size media pass through the classifier and fall into the retaining bins of an overhead media storage hopper. Up to 10,000 lb of media can be handled by this arrangement. In the skip-station automated system, the barrels move from one finishing tank to the next with all barrels indexing at the same time. A special feature of this system is the automatic programming which permits barrels to by-pass tanks by a preselector switch on the control panel. The in-line system employs a power-and-free conveyor system to take barrels into the finishing system. Barrels index simultaneously from one tank to the next by automatic walking beam. After completing the process, barrels enter the unloading station where they are positioned and emptied by a jog switch. **ALMCO Div., Queen Stove Works Inc.,** Albert Lea, Minn.



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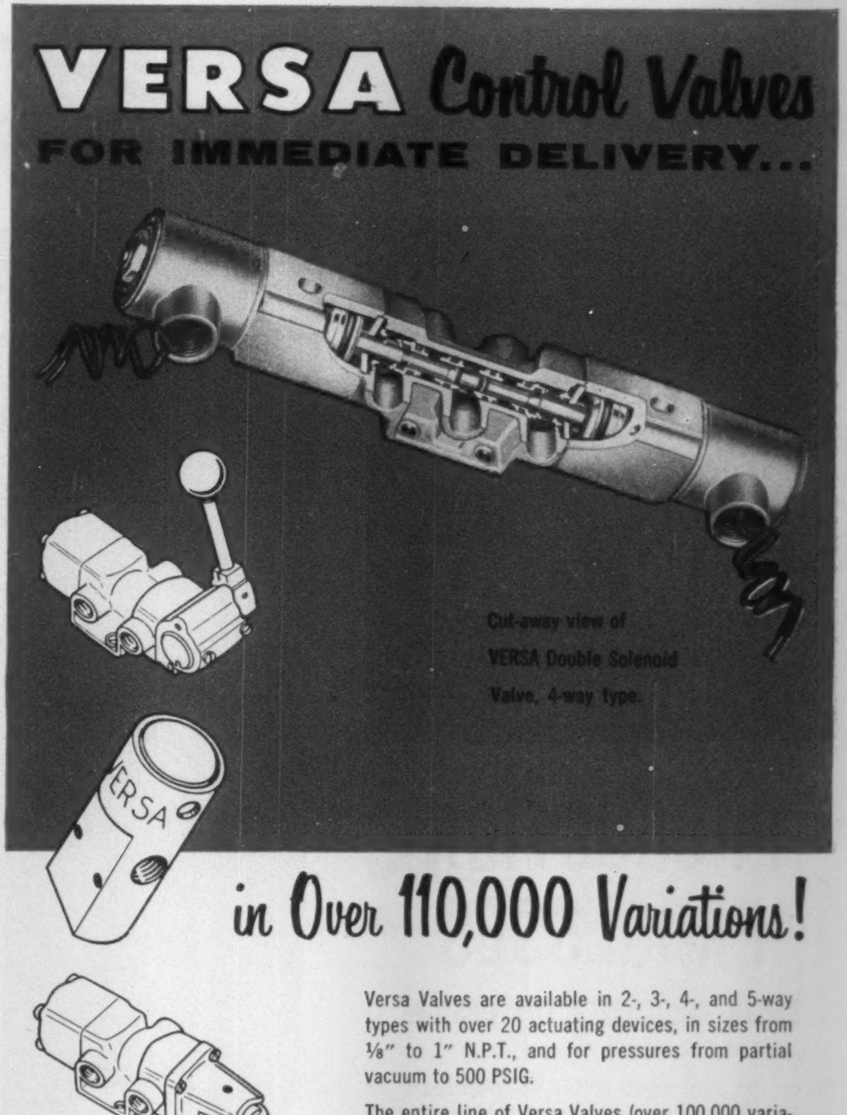

VERSA Control Valves FOR IMMEDIATE DELIVERY...

Cut-away view of
VERSA Double Solenoid
Valve, 4-way type.

in Over 110,000 Variations!

Versa Valves are available in 2-, 3-, 4-, and 5-way types with over 20 actuating devices, in sizes from ⅛″ to 1″ N.P.T., and for pressures from partial vacuum to 500 PSIG.

The entire line of Versa Valves (over 100,000 variations) are stocked by authorized Versa distributors, strategically located throughout the United States and Canada.

All Versa Valves are triple pressure and functionally tested under water for guaranteed leakproofness . . . actually exceed J.I.C. standards.

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The entire line of VERSA Valves is explained in our new comprehensive Folder #14

VERSA

VERSA PRODUCTS COMPANY INC.
248 SCHOLES STREET
BROOKLYN 6, N. Y.

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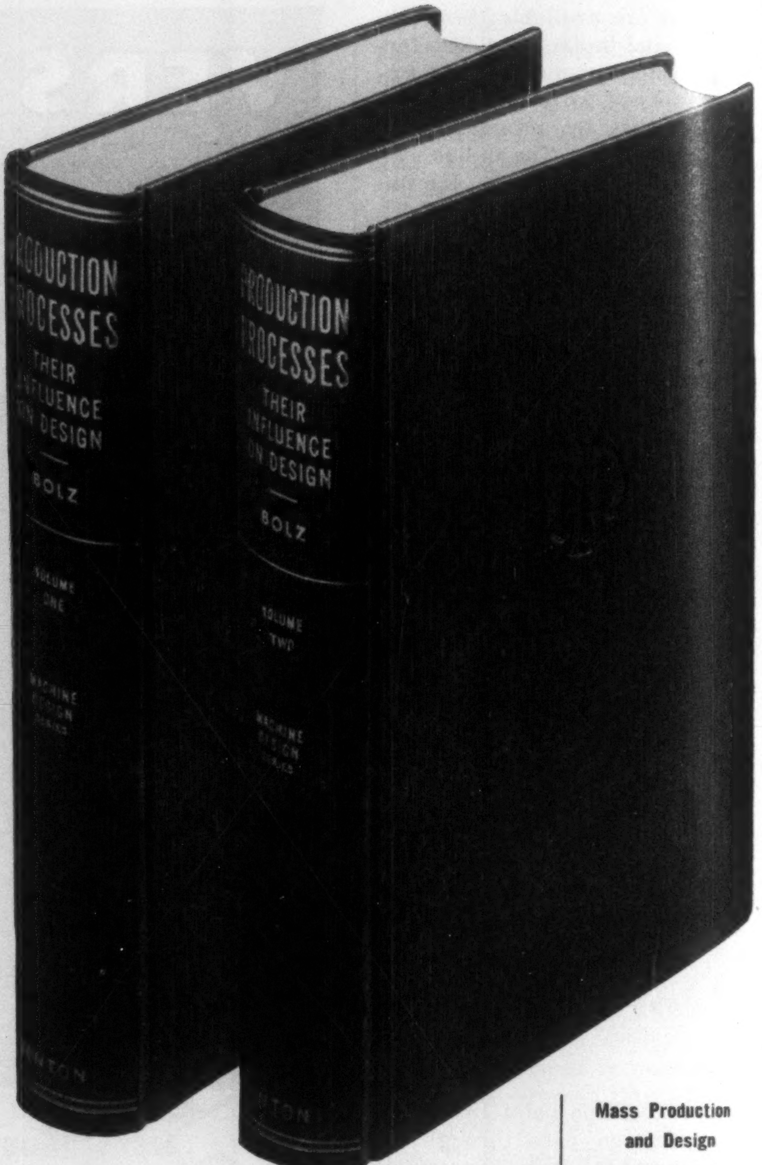
PRODUCTION PROCESSES
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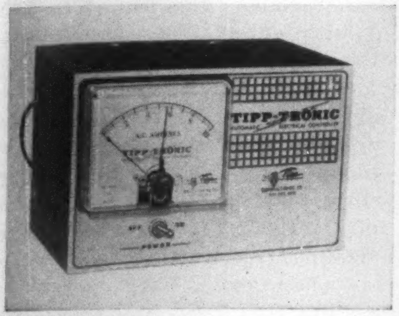
AUTOMATION new components

Parts, elements and devices designed for creating more automatic systems

For detailed information and literature, use card page 17



Safety Controller

Designed to provide warning and prevent damage from abnormal load conditions of any kind on electrically driven conveyor systems, automatic safety controller is called the Tipp-Tronic. The electromechanical device eliminates the need for shear pins, slip clutches and other mechanical safety devices often used on conveyors where they and/or adjacent equipment may be damaged by accidental jam-ups. The unit also affords protection against extreme overload and the need for lubrication which results in the minimum line pull to keep within its ultimate rating. The Tipp-Tronic not only features conveyor protection but also provides electric motor protection at an even finer control than normally used in conjunction with electric motors. The safety control unit instantly and automatically shuts off the conveyor system at any predetermined load setting. Highly sensitive and accurate, the device measures and acts upon variations from normal load over a wide range. It may also be set up to give warning or alarm of impending trouble before the shut-off stage is reached. The Tipp-Tronic is supplied for use with Tipp conveyor systems, and is also available for use with other types of electrically driven conveyors, either as original equipment or as an accessory to conveyors already installed. On multimotor driven conveyor applications, one Tipp-Tronic may be used as a control on the total current of all the motors, or one unit may be used with each motor. The controller is not affected by line voltage variations. On most conveyor applications, the unit is reset manually after it has given an alarm and shut off the system. **Tipp Mfg. Co.,** Tipp City, O.

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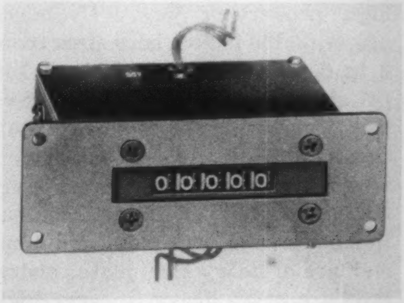

Electric Counter

Well suited for inventory control, new electric counter features both add and subtract operation. It adds one on impulse from one contact switch and subtracts on impulse from a second switch. It is used in production record systems for immeditate registration of stock reservation, withdrawals, or additions. It also may be used to indicate the number of pieces on a conveyor line at any time. The pieces fed into the line add counts, while the pieces removed subtract counts. Operating speed is up to 500 counts per minute. Standard voltage is 110v, 60 cycle ac. Voltage fluctuations on normal industrial circuits have no effect on the accuracy of this model. **Durant Mfg. Co.,** 1997 N. Buffum St., Milwaukee 1, Wis.

Circle 433 on Inquiry Card

Dual Lamp Indicator

Designed to meet requirements of military and commercial specifications, new miniature indicator lamp is used in automatic machinery, control systems and instrumentation. Miniature indicator light contains two independently wired bulbs and indicates four different conditions. The dual lamp indicator is 1.8 inches long and mounts in a 0.75-inch diameter hole in panels up to 3/16-inch thick. The replaceable plug-in bulb assembly contains two neon or two incandescent bulbs and is available in amber, red, blue, green, or clear. The insulated case is made of black anodized aluminum. **Eldema Corp.,** 9844 Remer St., El Monte, Calif.

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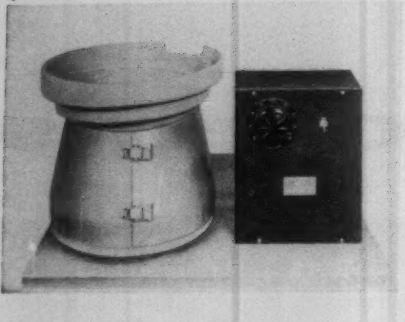

Feeder and Power Unit

Developed for use in connection with small parts feeder, new vibratory power unit is designed on a new three-spring suspension principle. The springs are nearly vertical to accomplish a gentle flow of parts and to increase production. This principle also permits perfect balance and lends itself to the round design which allows the unit to fit anywhere. The solid base unit is surrounded by a cover which is held in place by easy to open or close snap lock fasteners. Feeder and power unit are expected to fulfill the needs of the machine assembly manufacturer, since construction is immediately accessible and the controls can be set near the operator's position or in a large assembly machine. **Perry Equipment & Engineering Co.** Erie, Pa.

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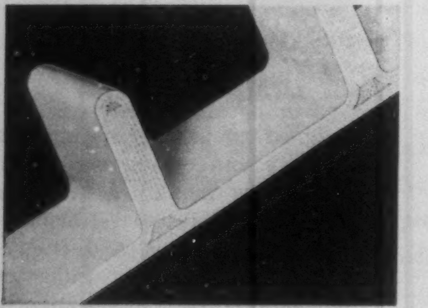

Cleated Conveyor Belt

Designed for incline or decline conveying, conveyor belt is made of a fabric reinforced cleat with no joints, no cracks and no gaps. Cleats can be furnished in any height, width and spacing, and as stiff or as flexible as desired. They will flex around pulley diameters, compatible with weight of the belt. They can be supplied in rubber, neoprene, or special compounds for resisting grease, oil, juices, chemicals, etc. From a sanitation viewpoint, cleated belts are desirable since there are no cracks or crevices for bacteria or other undesirable matter to accumulate. Cleated belts have no rivets, bolts or nuts to pull loose, giving greater belt life and reducing maintenance costs. **A. J. Sparks Belting Co.,** 867 Grandville Ave., S.W., Grand Rapids, Mich.

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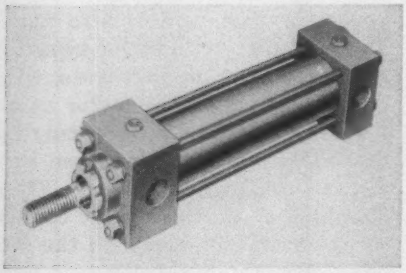

Heavy Duty Cylinders

Ultra-mation cylinders is the name given to models in new line of nonrotating, double-acting, square-end cylinders. Previously these cylinders were built only as specials for unusually difficult, high production jobs. Cylinders are available in five bore sizes from 2 to 6 in. and in pressures to 150 psi air, or to 500 psi oil. The five basic mounting styles are: foot, trunnion, flange, clevis, and pivot, with interchangeable covers permitting multiple mounting combinations. Covers, both front and blind end, are of heavy steel plate; piston rods are extra heavy to carry high impact loads and have highly polished surfaces to assure minimum friction and maximum packing life. Rod wipers are of synthetic rubber, assuring dirt-free rod on instroke. Cylinder tubes are hard drawn and corrosion resistant for low friction. Pistons are of high quality steel construction; ports are unobstructed and can be relocated to any 90 degree position by rotating cylinder covers. Tie rods are extra heavy to resist shock loads and to maintain proper tension on cover gaskets. Cushioning is available for either or both cylinder ends as specified. **Logansport Machine Co.,** Logansport, Ind.

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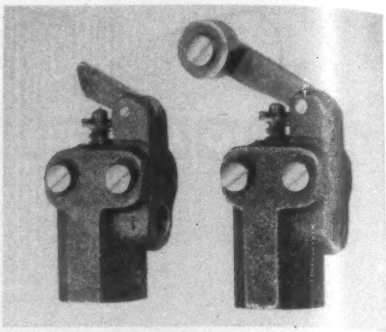

Two-Way Air Valves

Especially designed for high speed automation applications, two-way air valves are being used for automatically ejecting stampings from punch presses and kick presses, and for providing an automatic air blast for removing chips, dust and shavings in connection with drill press, plastic molding, cold heating and machining operations. They operate directly from any compressed air line, without requiring the use of a filter, to produce a powerful, automatic air blast which can be accurately timed as part of the work cycle by actuating the valve trigger with any suitable cam or tripping device. The valve is constructed of solid cast brass with hardened steel parts and is flat and square on both sides to make it easy to install on any machine surface or to assemble several valves in a row for multiple air blasts. **W. I. Martin & Co.,** 224 S. Michigan Ave., Chicago 4, Ill.

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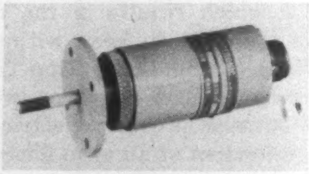

Displacement Transmitter

Differential transformer type displacement transmitter will transmit motions from 0.000001 to 0.125-inch with high resolution, accuracy and stability. Features providing convenience of installation and operation include a mounting flange, connector, bearing aligned spring loaded plunger, and a micrometer zero adjustment which allows mechanical and electrical zero to be adjusted with precision after installation. Sensitivity is 5 mv per 0.001-inch with 6.3 v, 60 cps excitation. Output impedance is 200 ohm; linearity is 0.5 per cent. Full scale output for 0.00025-inch displacement is obtainable using indicating or recording instruments available. **Daytronic Corp.,** 216 S. Main St., Dayton 2, O.

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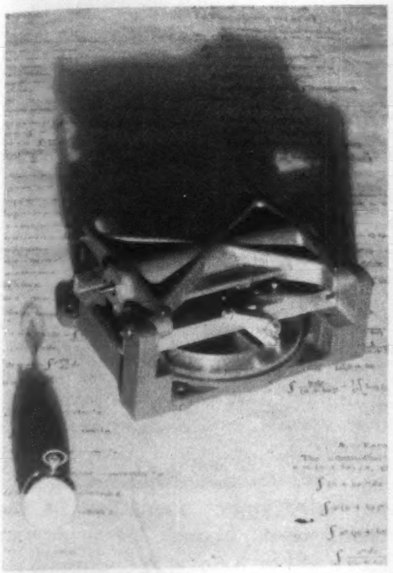

Integrators

Originally developed for use in analog gunfire control computers, 2½ and 5-inch integrators are available commercially as standard units in new line of integrators. Units utilize the disk, balls and roller design which employs two hardened steel balls in a carriage between input disk and output roller to reduce friction to a minimum. Patented ball roller tilt device minimizes ball slip for all carriage positions, and is supplied as standard on both integrator sizes. High precision units are used for a wide variety of open and closed loop applications. Maximum force to move carriage is ½ oz, and maximum input torque at zero load is ½ oz-inch. Integrator is used as an accurate component in airborne systems. **Ford Instrument Co., Div., Sperry Rand Corp.,** 31-10 Thomson Ave., Long Island City 1, N. Y.

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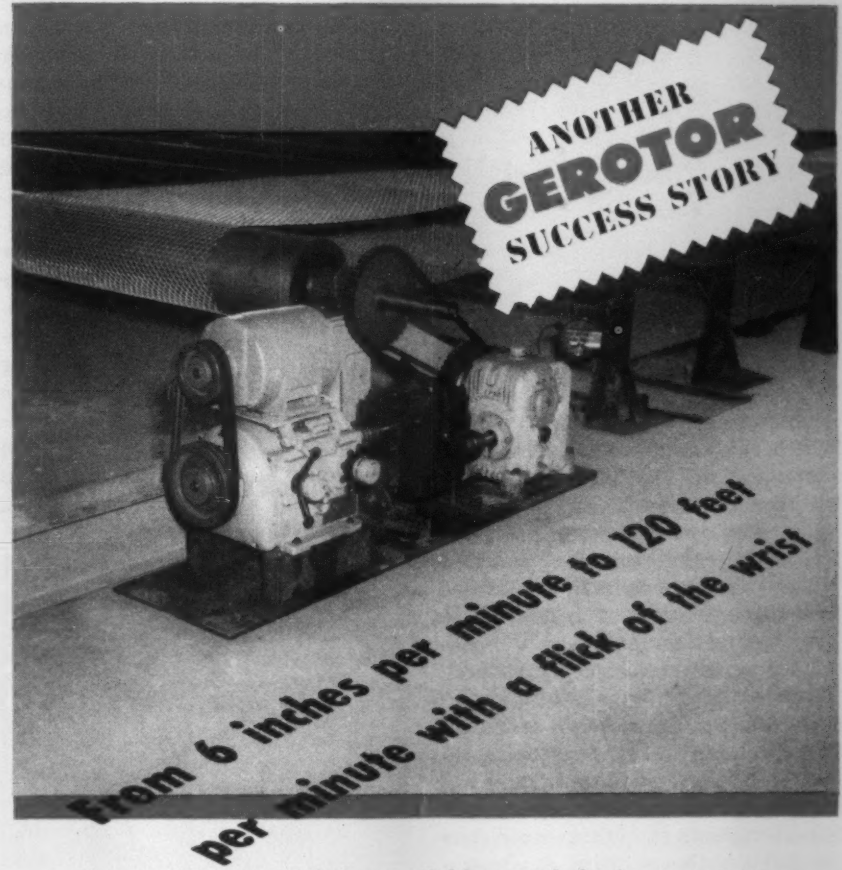
ANOTHER GEROTOR SUCCESS STORY
From 6 inches per minute to 120 feet per minute with a flick of the wrist

Our customer* needed a variable speed device to power a conveyor "assembly and test stand" which would accommodate metal conveyors up to 18 feet in width and up to 100 feet long. The Gerotor Variable Speed Hydraulic Transmission was the drive selected because it has a:

1. *wide enough speed range*
2. *smooth enough power flow*
3. *built-in overload protection*
4. *compact size, and*
5. *low maintenance factor.*

The installation engineered by Gerotor allows the operator to run the conveyor at speeds *from a smooth creep condition of 6 inches per minute to 120 feet per minute.* The added versatility of being able to adjust the torque output at any speed was theirs at NO EXTRA COST, and the conveyor can be stopped or reversed by means of the Gerotor Transmission.

If you have a hydraulic transmission problem . . . bring it to Gerotor. Free literature available . . . *write:*

**name on request.*

Progress Through Fluid Power by—

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Hydraulic Pumps and Motors

Variable Speed Hydraulic Transmissions

PneuBin—Pneumatic Bin Evacuators

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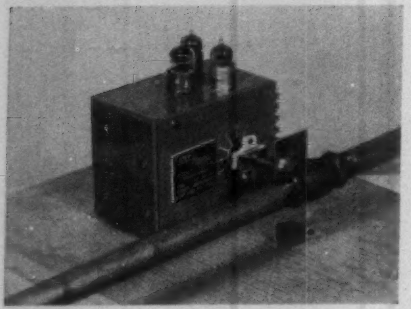

Servomechanism Unit

Advantages for applications which can be controlled in discrete steps are provided by small, power line operated servomechanism. Unit is a development resulting from automatic range switching vacuum tube voltmeter which eliminates manual operation of meter range controls. Servomechanism contains a rotary selector switch with shaft extension which automatically rotates in discrete steps in one direction in response to an input dc voltage. Connections to the switch can be made through external terminals so that user has available both a rotating shaft position and switch connections through which other circuits may be controlled. **Bergen Laboratories,** 11 Godwin Ave., Fair Lawn, N. J.

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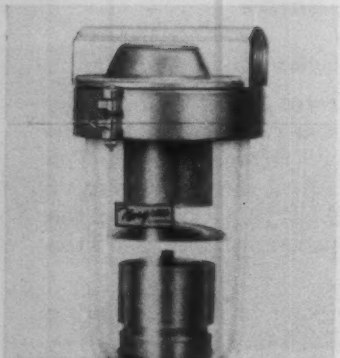

Air Line Filters

Automatic draining facilities and larger sizes are included in new series of air line filters. Two of the new models are completely automatic. They are designed to create a strong centrifugal force that removes a high percentage of moisture from the air stream. Both models are available with a choice of three types of filter elements for the removal of solids: The standard 200 mesh wire screen and two optional 25 and 64 micron sintered bronze elements. A float actuated drain mechanism discharges collected moisture automatically under constant or fluctuating air pressure and with or without air flowing. Special protection is provided to prevent entry of solids into the drain mechanism, avoiding clogging and reducing wear. The large water capacity of approximately 1¼ pt which controls drain frequency, keeps wear on the drain mechanism at a minimum. **C. A. Norgren Co.,** Englewood, Colo.

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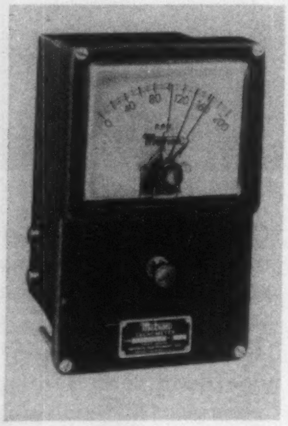

Tachometer

Designed for use in sounding alarms, turning on light signals, stopping or starting equipment, opening or closing valves, or controlling speeds, new tachometer unit not only indicates speed, but actuates self-contained power relays that signal overspeeds and underspeeds. High and low limit pointers are independently adjustable. These pointers act as a single-pole, double-throw switch with the regular speed pointer acting as the switch center arm. A manual reset pushbutton is used to reset the tachometer after the relays have signaled a high or low speed. Unit is available with any one of 48 different scales, marked in any rate such as r. p. m., f. p. m., or sheets per hour. **Metron Instrument Co.,** 432 Lincoln St., Denver 3, Colo.

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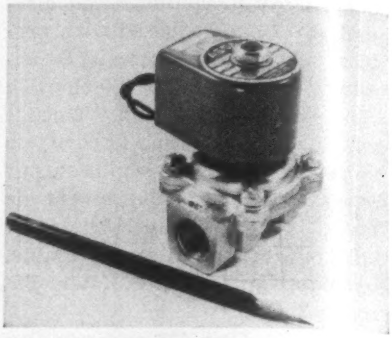

Solenoid Valve

When combined with single or double acting pneumatic or hydraulic power cylinders or diaphragm operated power heads, three-way solenoid valve provides an ideal means for securing automatic and remote control of various types of machinery. Internal pilot operated valve utilizes three operating parts: Two hycar diaphragms and one stainless steel solenoid core. Closely fitted parts, sliding glands, stuffing boxes, seat regrinding and lapping have been eliminated. Valve will operate under severe conditions up to 400 cycles per minute. Unit quickly converts from normally closed to normally open operation in the field. Full ⅝-inch pressure and exhaust ports provide maximum recycling speed. Valve is rated for 250 psi on liquids and gases and mounts in any position. **Automatic Switch Co.,** 391 Lakeside Ave., Orange, N. J.

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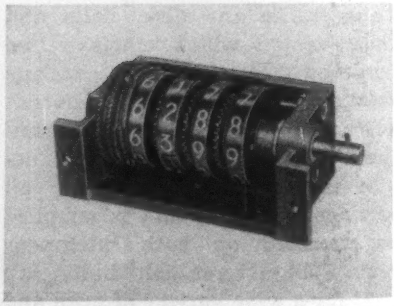

Mil Counter

Applications of new mil counter include systems in which angular indications must be expressed in mils instead of in degrees, such as are required in gun directing and fire control systems. New unit, which has four drums, provides 10 counts on its unit drum for each revolution of its input shaft, from which upward counting takes place through clockwise rotation. The counter, Model 1864, can be supplied with left and right, or left hand shafts in any lengths specified. Counting from 0 to 6399 mils with return to 0, Model 1864 is reversible at any point in its complete cycle, and is rated at 1800 r. p. m. It may also be furnished with maximum indications of 3199 mils. Counter is equipped with Oilite bearings, but ball bearings may be specified if required. Corrosion-resistant contruction is featured throughout. **Bowmar Instrument Corp.,** 2415 Pennsylvania St., Fort Wayne, Ind.

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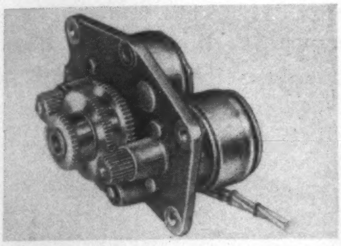

Digital Shaft Pulser

Readily adaptable to remotely activate counters, switches or indicators in the fields of automation and data processing, new digital shaft pulser is also used in conjunction with digital computations where display is required in analog form. The digital shaft pulser receives current pulses which rotate the shaft forward or backward a predetermined number of degrees per pulse. The basic pulse unit rotates 6 degrees per pulse. With the addition of simple gear combinations to the basic pulse unit, the digital shaft pulser will step any desired number of degrees up to 36 degrees. The exact number of degrees per pulse maintained will be governed by the accuracy of the detent, plus the tolerance held by the gear train. Current pulse required is approximately 80 ma for 10 milliseconds, and pulsing up to 40 per second can be obtained, depending upon the load. **Newton Co.,** 55 Elm St., Manchester, Conn.

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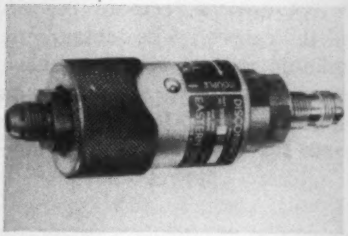

Pneumatic Disconnect

Any pneumatic connection is instantaneously converted into a straight-through line by new pneumatic disconnect. Pressure drop through the disconnect is equivalent to that of a straight tubing section. When disconnected, the checked end serves as a bubble-tight, leakproof shutoff valve. Another feature of the disconnect is the positive ball lock which guarantees safety of the connection under severe vibration and also provides a sight-and-feel indicator. A ¼ turn by hand is required to connect or disconnect. No tools are needed. When disconnecting, safety interlock automatically bleeds down trapped air, eliminating danger to personnel. Unit can be disconnected or connected under pressure as high as 3000 psi. Pneumatic disconnect is available in ¼ and ⅜-in. sizes. It has been used as standard equipment on military aircraft and has successfully passed severe qualification tests under conditions of extreme temperature and vibration. **Eastern Aircraft Products Corp.,** 229 River St., Orange, N. J.

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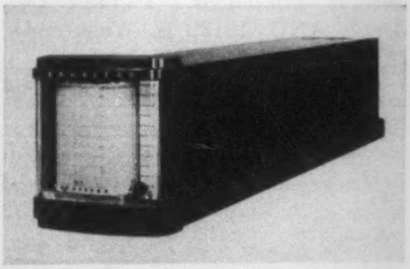

Electronic Recorders

Line of recording millivoltmeters and microammeters has measuring element that is over 50,000 times more powerful than conventional direct-deflect movements. The pen drive mechanism has ample power to operate alarm contacts with no loss of accuracy. The electronic recorder ~~transcribes on a~~ 3-inch wide chart while using panel space of less than 25 square inches. Both continuous strip charts and IBM type card charts are available. Recording is on straight-line co-ordinates. The recorder measures input signals with electromechanical transducer and amplifier which drives a rotary solenoid to position the pen. A feedback spring from the pen arm to the input transducer force balances the pen position in precise relationship with the input signal. The resulting power eliminates the limitations of low-level electrical measurements, such as pivot friction errors, vibration effects and excessive maintenance. The recorder is available as a microammeter in ranges from 0 to 200 microamperes to 0 to 100 milliamperes. As a millivoltmeter, it is available in ranges from 0 to 20 mv to 0 to 100 v with input sensitivity to 6700 ohm per volt. Recorder can be furnished with single high or low, or high and low alarm contacts. **Manning, Maxwell & Moore Inc., Industrial Controls Div.,** Stratford, Conn.

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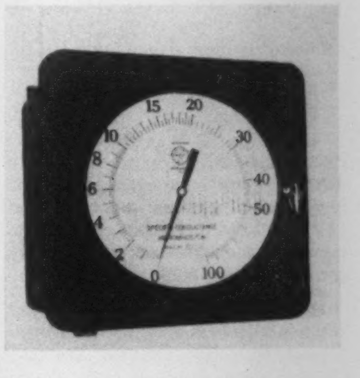

Indicator-Controller

Designed primarily for measurement and control of solution concentration, new indicator-controller is available with pneumatic transmitter as well as precision switches for electrical control. The Type RI indicator controller is a self-balancing Wheatstone bridge available with either manual or automatic temperature compensation for electrolytic conductivity measurement. The introduction of the pneumatic transmitter on the RI permits operation of pneumatic

NOW... Noise Free A.C. Power!

NEW CURTISS-WRIGHT DISTORTION ELIMINATING VOLTAGE REGULATOR

- Reduces typical power line distortion to less than 0.3%
- Furnishes 1.4 KVA of distortion-free power
- Electronically regulates 115 V output to ±1%
- Recovery time less than 1/50 cycle
- Provides additional 4 KVA of ±1% electromechanically regulated power
- Electromechanical time constant only 0.6 seconds
- Electromechanical regulator, unlike usual magnetic voltage stabilizer, introduces no distortion or phase shift

Here at last is the ideal solution to the disturbing problem of harmonics and low frequency noise appearing in 115 V., 60 cps power sources. In one compact package, every laboratory can now obtain *both*

1) distortion-free, regulated power when needed, and simultaneously

2) a large supply of electromechanically regulated power for applications where normal line distortion is tolerable.

In addition to its general laboratory utility, this instrument is ideally suited for preventing instability and inaccuracy in a.c. computer system nulling operations. Many other applications. 230 V. model also available. Immediate delivery. $1,689 f.o.b. Carlstadt, N. J. Write for details.

Component & Instrument Department

ELECTRONICS DIVISION
CURTISS-WRIGHT
CORPORATION • CARLSTADT, N. J.

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control devices, remote recorders and indicators. The instrument is available with a single pneumatic transmitter and/or up to four precision switches. **Industrial Instruments Inc.**, Cedar Grove, N. J.

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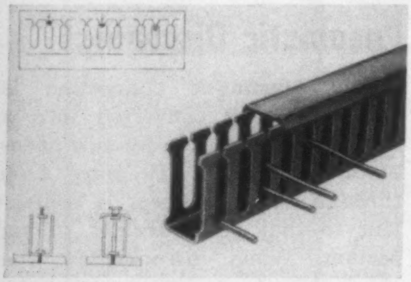

Control Panel Conduit

Wiring time is greatly reduced by new control panel conduit. Known as the Plastic Wiring Duct, it is available in a range of sizes from 1 inch by 1 inch by 5 ft to 3 inches by 3 inches by 5 ft. The new slot design introduces a simplified method of inserting and removing wires, since the wires are merely snapped in and out of the duct. It also permits the attachment of lugs before the wire is inserted and allows the wire to be removed with lugs attached. The fastener is also new in design; it holds both duct and cover and prevents either from slipping. Being an internal nut and bolt arrangement, it has no external projections, does not require space adjacent to the duct and in no way interferes with wire insertion. Threading of wires under fasteners is eliminated. **Panduit Co.**, Dept. ANC, 10132 S. Washtenaw Ave., Chicago 43, Ill.

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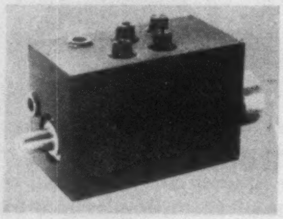


Control Valve

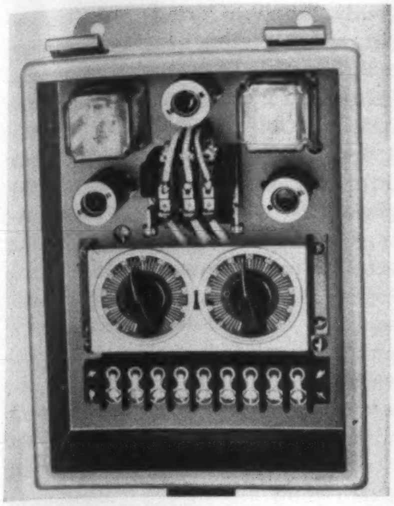
Designed for use in follow up positioning systems where mechanical input signals are obtained from cams or linkages, control valve features rectangular internal ports for linear flow at constant pressure drop; precision lap characteristics for positional accuracy; and hardened and lapped sleeve and spool construction. Positional feedback is obtained through use of differential input linkages or by displacing valve body relative to spool motion. Latter may be accomplished by placing the valve body directly on load cylinder or by mounting valve body on a slide actuated by the load motion. All hydraulic connections are grouped at the top of the valve so that multiple installations operated by a number of cams or linkages will occupy as little space as possible. Valve flow versus displacement characteristics are easily modified to suit individual power and stability requirements. **Hydraulic Controls Co.**, 87 Terrace St., Roxbury 20, Mass.

Circle 451 on Inquiry Card

Frequency Counter

Events per unit time meter presents readings in digital in-line readout form, eliminating ambiguity and reading errors. Readings stay constant during sampling period with no lost readings or hold adjustments. Sampling changes or dead times are eliminated. Decimal coded contacts provided in new instrument give simple, direct print out. No intermediate equipment is required to get printed information other than a printer. Where space is restricted or console type equipment is used, readout and controls of the instrument may be remoted on standard 1¾-inch rack panel. Counter is available in various models. **Electro Instruments Inc.**, 3794 Rosencrans, San Diego 10, Calif.

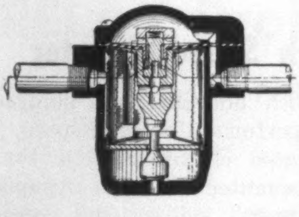
Circle 452 on Inquiry Card



Electronic Timer

Designed for use on life test equipment, proportioning controls and process or machine applications requiring *On-Off* timing cycles, electronic timer features independently adjustable *On* and *Off* time ranges. Timer has double-pole, double-throw load contacts rated at 20 amp, 115 v ac, noninductive load. Circuit employs cold cathode tubes requiring no warm up time before use. Accuracy is ±1 per cent and independent of line voltage fluctuations from 105 to 125 v. Available ranges are 0.3 to 25 seconds per section, and 0.5 to 50 seconds per section. Dials and controls are removable for remote operation. **Ferrara Inc.,** 8106 W. Nine Mile Rd., Oak Park 37, Mich.

Circle 453 on Inquiry Card



Air Filter

Lightweight air filter prevents deterioration of O-rings and other vital parts by eliminating sludge, abrasive substances, rust, scale and moisture from entering air operated tools. Fully automatic filter operates by the differential of pressure. As air flows through the unit, moisture, rust, grit, sludge and other abrasive substances with a specific gravity greater than air collect in main filter chamber of the unit. Sudden stoppage of air flow causes internal valve to change position. During this instant, water and foreign substances collected are discarded through the opening at the bottom of the separator. Compact unit weighs only 12 oz, with major parts made of lightweight aluminum. **Emco Pneumatic Corp.,** 1317-1319 Locust St., Des Moines, Iowa.

Circle 454 on Inquiry Card

Thermal Switch

Designed for applications wherever fast acting, sensitive, thermally responsive regulation is required for control of dangerously high or low temperatures, new thermal switch weighs less than 1 oz and features an operating differential of ±1 degree with extremely fast response. Switch has an effective calibration temperature rating from —20F to 1000F. The device will continue to operate accurately within its rated capacity even when subjected to momentary overshoots of 1000F beyond its rating. Electrical rating is 1½ amp at 28v dc resistive. Switch body is grounded to the mounting and one wire is connected to the head. It is made of all welded, corrosion resistant materials and is furnished with normally open or normally closed contacts. **Control Products Inc.,** 306 Sussex St., Harrison, N. J.

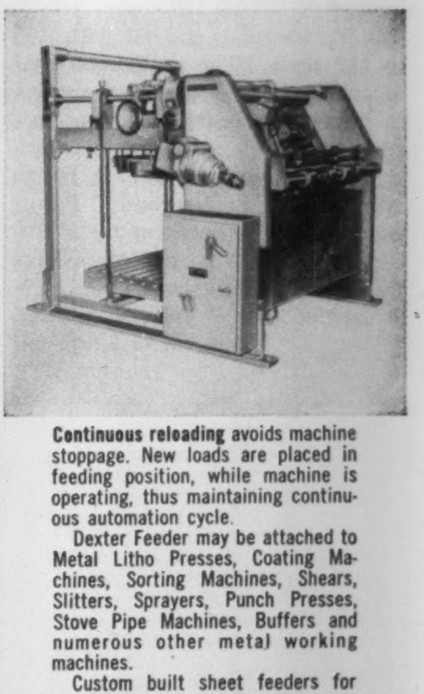
Circle 455 on Inquiry Card

DEXTER
AUTOMATIC
METAL SHEET
FEEDER

Metal sheets, automatically separated, picked up and advanced one at a time to feeding—in point of machine to which it is attached at speeds up to 150 sheets per minute.

Should two sheets adhere, they are automatically transferred to a reject tray. Rubber suction mouthpieces and drop rollers prevent scratching.

Standard Feeder handles metal sheets from 14" x 18" up to 36" x 44" between 24 and 38 gauge stock. Feeders for larger size and heavier gauge metal sheets also available.



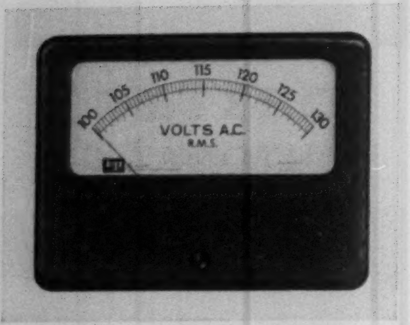
Continuous reloading avoids machine stoppage. New loads are placed in feeding position, while machine is operating, thus maintaining continuous automation cycle.

Dexter Feeder may be attached to Metal Litho Presses, Coating Machines, Sorting Machines, Shears, Slitters, Sprayers, Punch Presses, Stove Pipe Machines, Buffers and numerous other metal working machines.

Custom built sheet feeders for handling paper, cardboard, corrugated and other types of sheets are available to meet specific requirements. Inquiries invited.

DEXTER
EST. 1880
DEXTER
FOLDER COMPANY
General Sales Offices
330 WEST 42ND STREET
NEW YORK 36, N. Y.

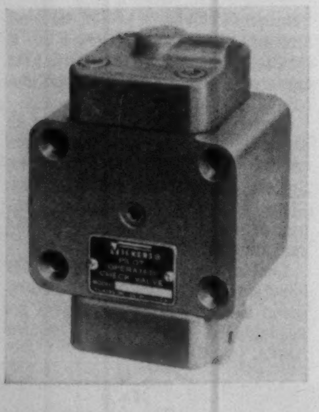
Circle 591 on Inquiry Card



AC Voltmeters

Useful portion of the conventional scale is expanded in line of ac voltmeters which are designed for panel mounting. Stock sizes with 115v base include 3½-inch round custom with 110 to 120 scale, 105 to 125 scale, 100 to 130 scale; 3½-inch round military with 110 to 120 scale, 110 to 130 scale; 3½-inch square custom with 100 to 130 scale; 4½-inch round military with 100 to 130 scale; 4 by 6 inch rectangular custom with 100 to 130 scale. The units read root mean square; maximum error due to harmonics is 0.004v times volt span times per cent harmonic content. Frequency range is 50 to 2000 cycles per second. Power consumption is between 1 and 2w, depending upon span. **Arga Div., Beckman Instruments Inc.,** 220 Pasadena Ave., S. Pasadena, Calif.

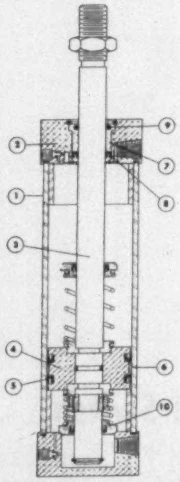
Circle 456 on Inquiry Card



Check Valve

Designed for use with ⅜-inch piping in industrial oil-hydraulic systems, gasket mounted, pilot operated check valve extends company line of gasket mounted units which are ideally suited for traverse and feed circuits, holding vertical loads and similar duty applications. New unit is of spring closed, poppet type construction. Spring closure design provides uniformly consistent operation regardless of valve mounting position. Valves can be arranged in control systems to block flow in a given direction until opened by remotely applied pilot pressure and to allow free reverse flow. Valve has a rated capacity of 8 gpm and is recommended for use in systems with operating pressures up to 2000 psi. Valves require pilot pressure greater than 40 per cent of system pressure to open. Units are available with either 30, 75, or 150 psi cracking pressure. **Vickers Inc.,** 1400 Oakman Blvd., Detroit 32, Mich.

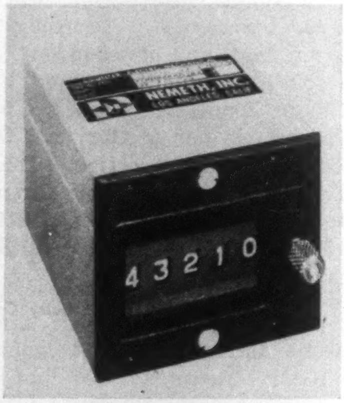
Circle 457 on Inquiry Card



Double Acting Cylinder

Unusual feature of double acting cylinder is that there is no metal to metal contact between its piston and the cylinder wall. This feature, which prolongs cylinder life, is achieved through the use of a tough nylon bearing wrapped around the outer diameter of the piston. Components and features on the cylinder are pointed out numerically on the photograph as follows: (1) Seamless steel cylinder barrel — hard chrome plated (2) cylinder heads machined to close tolerances from high tensile aluminum extruded bar (3) stainless steel piston rod — hardened, ground and polished (4) large surface piston and heavy steel thrust ring absorb shock forces (5) self-adjusting piston packings which yield negligible break out friction (6) nylon piston bearing prolongs cylinder wall life — with minimum friction (7) extra large piston rod bearing, Oilite cartridge type, with 1 by 1-in. surface area (8) self-adjusting piston rod packings (9) piston rod wiper protects rod packings and bearings, also stainless steel tie rods eliminate axial tension loads; design permits flush mounting (10) cushion arrangement with cadmium plated spring, spherical radius seal, and chamfered seat, assures positive cushioning with immediate acceleration on return stroke. Cushion design permits extra long adjustable cushions up to 6 in. for variable feed control. Cylinders are furnished with standard three-way flush-rabbet mountings — front, rear, and horizontal. Large unrestricted ports for maximum flow with minimum friction. Ports can be rotated to any 90-degree position in relation to each other and to the mount. **Alkon Products Corp.,** 206 Central Ave., Hawthorne, N. J.

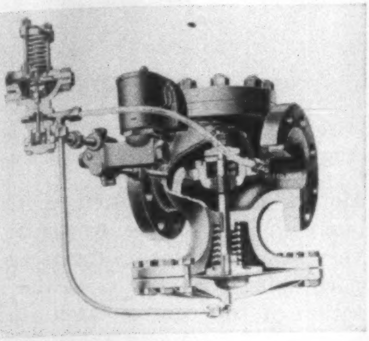
Circle 458 on Inquiry Card



High Speed Counter

Both addition and subtraction are performed by high speed, pulse actuated electromagnetic counter. The counter utilizes a dynamically balanced bidirectional stepping mechanism that cannot double index during shock, vibration or excessive electrical input. The life of the counting device exceeds 100 million counts, due to its impact free mechanism. Counter operates to 60 counts per second in either direction or to 50 cycles per second random input on dc. It is available for ac operation with an external rectifier. Power requirement is 15w, continuously rated. Coils are wound to specification for 6 to 250v operation, with a separate coil for each direction. **Nemeth Inc.,** 2223 S. Carmelina Ave., Los Angeles 64, Calif.

Circle 459 on Inquiry Card



Solenoid Pilots

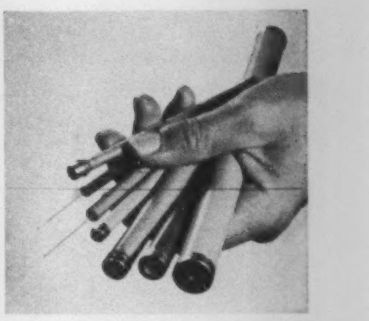
Designed for use with regulating valves, new solenoid pilots control heating, air conditioning, textile, chemical and other processing operations. Solenoid pilots are used to open or close regulating valves through power failure, pump or fan circuit power, thermostatic switches, pressure switches, level switches, timing switches and manual switches. Illustrated model provides for tight shutoff when the power to the solenoid coil is interrupted, while it includes all advantages of company's pressure regulator. It is used most frequently in combination with a thermostat to control both room temperature and radiator pressure, eliminating the need for a separate zone control valve. An extra pilot can be added to an existing regulator by lengthening tubing and ¼-inch pipe connections by a few inches. **Spence Engineering Co. Inc.,** Walden, N. Y.

Circle 460 on Inquiry Card

Selenium Rectifiers

Developed for high-voltage, low-current applications, five disk-type tubular rectifiers are available in sizes ranging through ⅛, 3/16, 9/32, ⅜ and ½ inch in diameter. Rectifiers can be obtained in assemblies of one to 260 cells, mounted without spacer washers in a phenolic tube. Each end is fully closed with a brass cap which is secured to the phenolic tube and provides contact ferrules for fuse-clip type mounting. Cells are rated 1, 2½, 5, 10 and 20 ma dc per cell, in a half-wave circuit using a condenser input filter at maximum ambient temperature of 35C. Rectifiers have a reverse voltage rating of 26v rms per cell. For use under varying conditions of temperature and humidity, hermetically sealed tubes are also available. In addition to tubular rectifier is line of power rectifiers, ranging in size from 1 by 1 inch to 5 by 6 inches. **Union Switch & Signal Div., Westinghouse Air Brake Co.,** Pittsburgh 18, Pa.

Circle 461 on Inquiry Card



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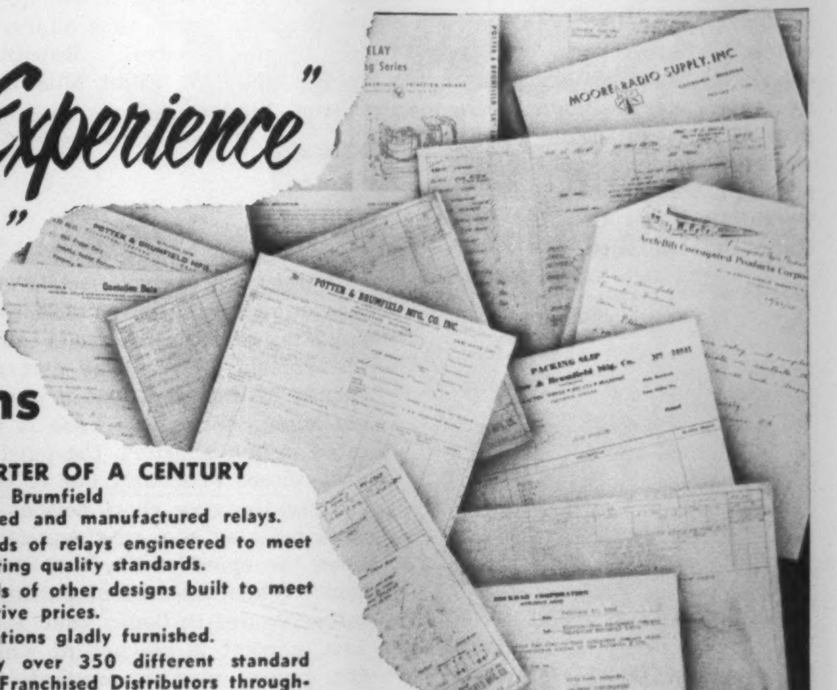

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Potter and Brumfield
has designed and manufactured relays.
Many thousands of relays engineered to meet the most exacting quality standards.
But, still thousands of other designs built to meet the most competitive prices.
Samples and quotations gladly furnished.
For quick delivery over 350 different standard relays stocked by Franchised Distributors throughout the United States and Canada.

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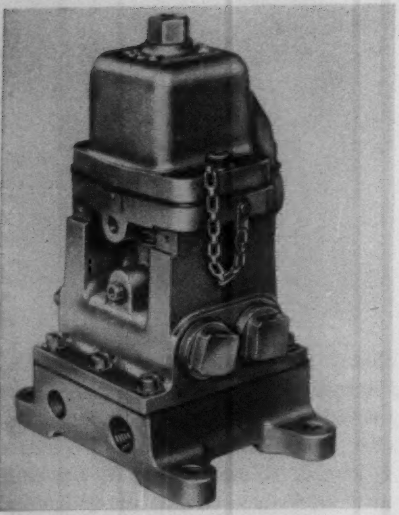
Relay illustrated (RS series) low cost sensitive type relay.

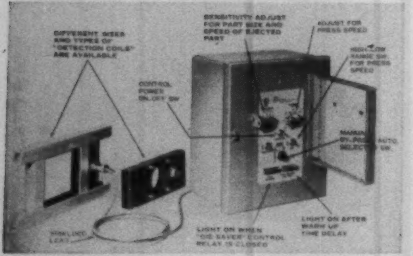
Circle 592 on Inquiry Card



Solenoid Assembly

Built to JIC standards, solenoid and cover assembly is designed for use on company line of base-mounted valves. Assembly can be applied to three and four-way types and to sizes from ¼ through 1¼ inch. Assembly protects solenoid from dust, splashing liquids and airborne contaminants. It can be manually operated without removing cover and becomes electrically inoperative when cover is removed. Providing ample wiring connection space and ring type connectors, assembly features captive type cover fasteners, chain to prevent loss of cover, threaded electrical conduit connection and provision for piped exhaust. **Ross Operating Valve Co.,** 120 Golden Gate, Detroit, Mich.

Circle 462 on Inquiry Card


DIFFERENT SIZES AND TYPES OF "DETECTION COILS" ARE AVAILABLE
SENSITIVITY ADJUST FOR PART SIZE AND SPEED OF EJECTED PART
ADJUST FOR PRESS SPEED
HIGH-LOW RANGE SW. FOR PRESS SPEED
CONTROL POWER ON-OFF SW
LIGHT ON AFTER WARM UP TIME DELAY
LIGHT ON WHEN "DIE SAVER" CONTROL RELAY IS CLOSED

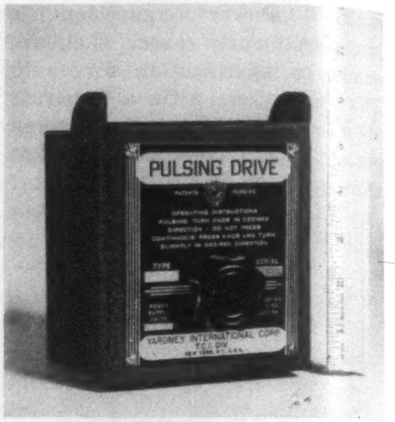
Electronic Press Control

Designed to reduce or eliminate the possibility of damage to dies and presses due to double heading on nonejected parts, electronic press control also reduces the possibility of accidents, allows faster automatic feeds, permits one operator to control more than one press, and counts only the parts stamped. The control, called the Die-Saver, is enclosed in a small shock mounted cabinet, which is portable for quick press mounting near any 115v, 60 cycle outlet. The unit prevents recycling if ejected parts fail to pass the detection coil. It may be used for any stamping application where the press cycle can be made to stop at the top of its travel as it completes 360 degree revolution, or can be made to stop just before the punch enters the lower die. The operating principle is based on stamped ferrous or nonferrous metal parts passing the detection devices at intervals set on the Die-Saver control panel. This causes an electrical impulse which energizes a control relay and closes a set of normally open contacts for a predetermined period. The contacts will stay closed as long as these impulses are repeated within the interval set on the dial, indicating normal part ejection. When impulses repeat outside of this interval, the parts are not being ejected fast enough and the relay contacts will open, stopping the press, thus eliminating manual control. **Robotron Corp.,** 21321 W. Eight Mile Rd., Detroit 19, Mich.

Circle 463 on Inquiry Card

Switching Device

Designed to control electric motors or magnetic valves, selective, pulsating switching device is called the Pulsing Drive. The unit responds to the operations of a single knob. When this knob is rotated in one direction, the pulsing drive closes selectively one of two circuits for very short periods of time repeated at a rate dependent upon the speed of the knob rotation. When the rate of pulsation increases due to faster knob rotation, a point is reached at which the pulses overlap so that the switching circuit is kept closed as long as the knob is rotated at that speed. The time period is easily adjustable within a wide range to suit local conditions. The Pulsing Drive provides single knob precision control of reversible motors. Motors may be rotated continuously for fast travel, or moved in very small increments for accurate positioning. A slow clockwise rotation of the control knob causes a series of relatively short electrical pulses to be applied to the motor winding, corresponding to the desired direction of rotation, and results in a corresponding motor motion in small increments. Slow, counterclockwise rotation of the knob causes reverse motor rotation in small increments. More rapid rotation of the control knob results in faster and more extended travel. **Yardney International Corp., T.C.I. Div.,** 44 Leonard St., New York 13, N. Y.



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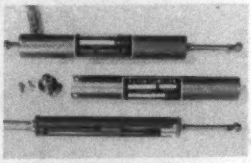
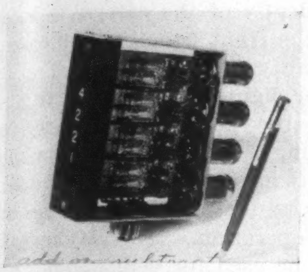


Miniature Potentiometer

Resistance values of miniaturized linear travel potentiometer are up to 60,000 ohms per in., with total travel up to 6 in. Either single or dual potentiometers are available in ½-in. diameter case. Ball type mounting provides universal alignment. Dual wipers are provided on each element for minimum noise and longer life. Resolution can be as low as 0.0008-in. with single-turn taps. Design permits complete preassembly and testing before insertion in case. **General Components Co.,** 801 Eighth St. SE., Minneapolis 14, Minn.

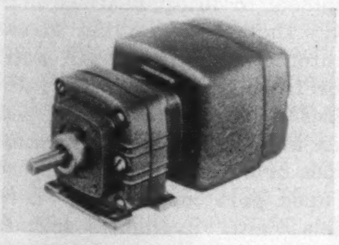
Circle 465 on Inquiry Card



Electronic Counter

Designed for use in the measurement and control fields, up and down decade counter is no larger than one-way counters. Reversible unit can be electronically or manually controlled continuously by either an external flip-flop or dc voltages. Applications range from continuously tracking digital voltmeters and data converting devices to integrators and digital differential analyzers. The internal gating is a circuit employing reliable, long-life neon bulbs. Readout is visual in binary coded decimal and electrical by staircase voltage indicating the count. Decades can be cascaded to add or subtract any desired number of pulses. Maximum continuous counting speed is 50,000 cycles per second. Add-subtract control is provided by two dc voltages of 115 and 250v (not critical) which are reversed to add or subtract and are supplied externally. Unit is open plug-in type with components rigidly mounted on printed circuit designed to plug into standard 11-pin octal type socket. **Controller Instrument Co.,** 1612 Que St., NW, Washington 9, D. C.

Circle 466 on Inquiry Card



Takeoff Heads

Designed to engage high speeds from 5000 to 30,000 rpm for full scale readings and to engage low speeds from ½ to 100 rpm for full scale readings on any of this com-

Saves 40% Space!

STRONGER, TOO

Than Outmoded
Tie Rod Cylinders!

OFF SHELF DELIVERY

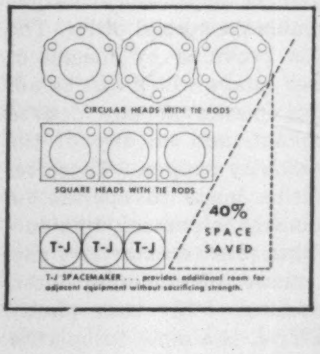
Only T-J

Spacemaker

CYLINDERS

Offer All The Extras As Standard!

- NEW *exclusive* Ingenious Cushion Designs . . . Super Cushion Flexible Seals for Air . . . New Self-Aligning Master Oil Cushion
- Compact design eliminates tie rods, saves up to 40% space
- Proven Performance . . . with Extra High Safety Factor
- Hard Chrome Plated Bodies and Piston Rods (Standard, at no extra cost)
- OIL pressure up to 750—AIR to 200 P.S.I.



T-J SPACEMAKER . . . provides additional room for adjacent equipment without sacrificing strength.

You'll find many answers to *automation* in your plant with T-J Spacemaker Cylinders! Designed with years-ahead features for top performance and dependability. Wide range of styles, capacities . . . for all kinds of push-pull-lift operations . . . reduces man-hours and costs! Write for bulletin SM-155-2. The Tomkins-Johnson Co., Jackson, Mich.

MEMBER OF THE NATIONAL FLUID POWER ASSOCIATION

T-J TOMKINS-JOHNSON
RIVITORS . . . AIR AND HYDRAULIC CYLINDERS . . . CUTTERS . . . CLINCHORS

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PRODUCTION ENGINEERS

JOIN THE LEADER IN AERO CONTROLS!

Honeywell needs top-notch Process Engineers at all levels of responsibility for directing the production of such *airborne* control systems as:

Inertial Guidance
Jet Engine Control
Fire Control and Bombing
Flight Control of Aircraft and Missiles
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Exhaust Gas Temperature Indication

Engineers selected will analyze designs, establish process methods and control, and guide designs toward economical and speedy production.

■ To qualify, you should be familiar with process evaluation, cost estimating, tool ordering, metals fabrication, and manufacturing-assembly operations. Your background should be in the area of *precision* electrical, mechanical, or hydraulic devices such as gyros, accelerometers, operational computers, pressure switches, amplifiers, calibrators, altitude compensators, and thermistor level switches.

■ These are permanent, career-building positions that Honeywell can offer because of its succession of achievements in airborne control systems, broad diversification, and healthy balance between civilian and military contracts.

CONSIDER THESE ADVANTAGES

■ Minneapolis offers you metropolitan living with a suburban way of life . . . A city of beautiful lakes with every recreational facility a few minutes from your home.

■ Outstanding educational opportunities . . . Liberal tuition allowances paid by Honeywell.

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■ Honeywell, the nation's leading supplier of control systems, manufactures over 10,000 diversified products. A sound growth company, Honeywell offers continuing expansion and permanent opportunities for you to advance.

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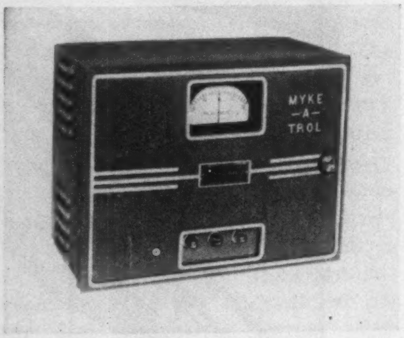
If you are interested in a career at Honeywell, call collect or send your résumé to Bruce Wood, Dept. AJ-6-108, Aeronautical Division, 2600 Ridgway Road, Minneapolis 13.

MINNEAPOLIS
Honeywell
First in Controls

Circle 594 on Inquiry Card

pany's indicators, new takeoff heads feature built-in gearing. A double-pole, double-throw switch together with a capacitor acts as a speed sensing element. When the takeoff shaft rotates either direction, the built-in gearing operates the speed sensing element. It produces a current exactly linear with respect to speed. Readings are unaffected by wide temperature changes; normal range is 0 to 150 F. Unit takes overspeeds up to five times the speed required for a full scale reading. **Metron Instrument Co.,** 432 Lincoln St., Denver 3, Colo.

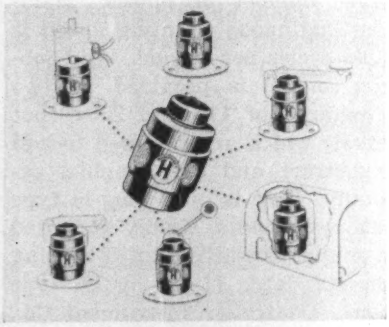
Circle 467 on Inquiry Card



Automatic Measuring Unit

Compact, packaged unit which contains a sensitive electronic mechanism controls quality during actual processing operations. The unit is designed for use with sensing elements which are built into the gage heads for most automatic measuring applications such as gaging and sorting, weighing, pressure control, fatigue testing, inspection and thickness control. System of measurement has an overall accuracy of 2 per cent using standard transducers. Linear full scale displacement ranges of ±0.1 inch to ±100 microinches are incorporated in 20 scale divisions. Larger displacement ranges are available on special order. The control is provided by means of two power relays which can be adjusted to operate at any desired control point, and on any of the four sensitivity ranges. These relays can be made to operate on plus or minus tolerances, two successive plus tolerances or two successive minus tolerances by internal switching. The unit, called Myke-A-Trol, is simple to operate. A calibrated meter, operated independently of the relays, is located on the front panel, to indicate the quantity being measured. Indicator lights show when the unit and the power relays are functioning. A calibrating pushbutton is also located on the panel, to give an instant check on the overall operation. The Myke-A-Trol can be used for continuous or momentary gaging. When momentary gaging is desired, a disabling circuit, operated by a cam switch, or other means is provided. Since the Myke-A-Trol response time is approximately 1 millisecond, gaging time is normally limited only by the mechanics of the handling and switching system. The Myke-A-Trol is built for continuous operation, with its own internal line voltage regulation. Standard industrial vacuum tubes are used in the unit. The case is shock mounted, so that it can be installed directly on a machine to give trouble-free performance. **Industrial Electronics Inc.,** 8060 Wheeler St., Detroit 10, Mich.

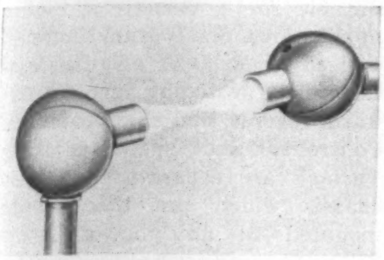
Circle 468 on Inquiry Card



Control Valves

Designed for use in original equipment or in applications in industry that require either manual or automatic valving of air, water, oil or freon, line of control valves utilizes a single basic valve body which may be used either normally open or normally closed, depending upon port connections. Seven models are available—solenoid, cam operated, palm button, fingertip, foot operated and two types with hand lever. Known as the "Quick-Dump" valve, the opening, closing and holding action are affected by the pressure of the air or liquid. There are no internal packings, springs or pistons in the valves, and no sliding of metal-to-metal contacts. The valve is adapted for applications up to 125 psi and under temperature variations from −40 to 225F. A momentary electric impulse triggers this valve to open or close positions. There is no prolonged flow of current since no current is required to hold. New type of double coil, impact solenoid, which develops greater thrust from smaller coils, has been developed for the valve. **Humphrey Products,** 202 N. Park St., Kalamazoo, Mich.

Circle 469 on Inquiry Card



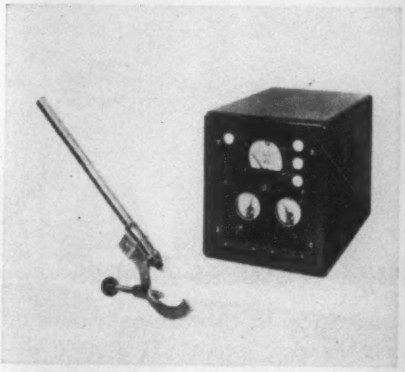
Electronic Eye

Designed as a standardized tool for automation, electronic eye system makes it possible to feel, with only a light beam, position, movement, texture, size, quantity, color and many other qualities under applications where objects and materials must be watched and controlled but not touched. Electronic eye systems feature spherical shaped housings for the electronic eye and for the light source. Completely self-contained, one 5-inch diameter sphere houses an eye, amplifier, and pilot relay; the only exposed wires are to the power source and to the controlled circuit. The other sphere houses the light source lamp. Each sphere mounts directly on the conduit which carries its electrical leads. No other mounting devices or external equipment are necessary. The sphere design permits easy swiveling to point the eye in any direction; conduit mounting permits simple installation at any convenient point. Output of the electronic eye system can be used to operate a counter, sorter, alarm, indicator or any system which can be electrically controlled. **Hancock Industries,** Dept. 2, 6711 S. Sepulveda Blvd., Los Angeles 45, Calif.

Circle 470 on Inquiry Card

Grinder Control

Electronic unit for automatic control of plunge grinders is called the MICROtrol type 150. The unit gages workpiece diameter continuously during grinding and uses the gaging information for automatic control of the final size of the workpiece. When used with a grinder that is equipped with electrically operated feed control and wheel withdrawal devices, the unit automatically controls such variables as the change from fast infeed to slow, amount of stock removal during sparkout, and wheel withdrawal at final size. In addition, part size is continuously presented on a set of direct reading indicators, and indicator lights signal arrival at the various size limits, including final size. Advantages of the control unit, which can be installed without difficulty on either new or existing grinders, include reduction in scrap through better control of the final size. This is accomplished by the automatic multipoint control of wheel feed and withdrawal. Additional advantage is the improvement in surface finish, brought about by the accurately controlled sparkout. In some applications, the surface finish has been sufficient to eliminate the need for honing after grinding. The standard MICROtrol type 150 is for true diameter gaging on center type grinders, with three-point grinder control and wheelguard type mounting for the gaging caliper. Special units are available for other applications, such as chordal gaging on external centerless grinders. **Airborne Instruments Laboratory,** Industrial Products Dept., 160 Old County Rd., Mineola, N.Y.



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ELECTRIC COUNTERS
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200,000,000 COUNT LIFE

PIC SUPER-WIZARD
1000 CPM.
5 watts input.
Balanced Armatures.
4 and 6-digit models in basemount, panelmount and dustproof enclosed types for 60, 40-50, 25 cycles and DC; all voltages to 230.
Purchase cost only 18c per million counts.

50,000,000 COUNT LIFE

PIC 600
1000 counts per minute
7 watts power consumption
Balanced armature
Quiet operation. No AC hum.
Tamper proof housing.
Lubrication not required.
Available in basemount and panelmount models—also to count dozens, for 60, 40-50, 25 cycles and DC; all voltages to 150.

6,000,000 COUNT LIFE

PIC MERCURY
4-digit Reset
600 Counts per minute.
3 watts power input.
4-digit Basemount and Panelmount models also to count dozens — all voltages to 115, AC or DC.

3,000,000 COUNT LIFE

PIC MERCURY
5-digit non-reset
600 Counts per minute.
3 watts power input.
Tamper proof construction.

See your PIC Representative or write

PIC
PRODUCTION INSTRUMENT CO.
704-26 W. Jackson Chicago 6, Illinois
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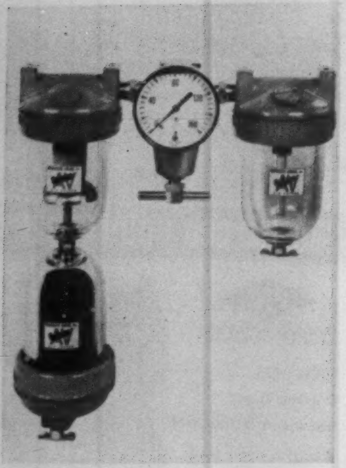
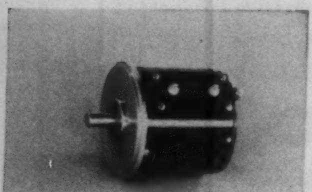


Air Control Assembly

Compressed air used in the operation of pneumatic equipment is automatically filtered, regulated and lubricated by new air control assembly. Sludge, formed of dirt, scale, rust and moisture is automatically trapped by the filter. An automatic drain trap attached to the bottom of the filter collects moisture from the filter, eliminating periodic draining maintenance. After the clean air is regulated to the desired pressure, a fine oil mist is added by the lubricator. This lubricated air is carried to the operating parts of the equipment, thus insuring high efficiency and low maintenance. Air control assembly provides visibility of operation of each unit while up to 98 per cent of free moisture is removed at a negligible loss in air pressure. **Airmatic Valve Inc.**, 7317 Associate Ave., Cleveland 9, O.

Circle 472 on Inquiry Card



Precision Potentiometer

Independent linearity as close as 0.01 per cent or better is possible with ten-turn, 2-inch outside diameter, precision potentiometer. High stability combined with rugged construction assures high accuracy even under severe environmental conditions. The resistance coil is externally wound on a nonhygroscopic ceramic core which is chemically inert, dimensionally stable and has a low coefficient of expansion. Metal-to-metal traveling nut stops withstand static torque of 500 oz-inches. The wiper arm is independent of the stops, and to minimize wear, only the wiper touches the resistance element. The 2-inch diameter cover is precision machined aluminum. Electrical angle is 3600 degrees with 90 degree overtravel at each end. All taps are welded to a single turn of wire. Resistance values of 1 to 100 K can be supplied. **Litton Industries,** Components Div., 336 N. Foothill Rd., Beverly Hills, Calif.

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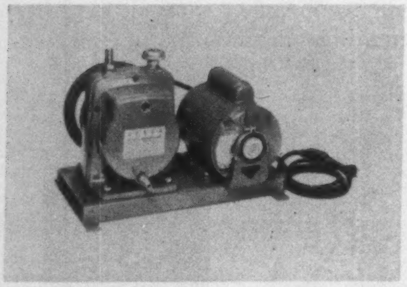

High Vacuum Pumps

Addition to the company line of pumps, new model Hyvac 2 delivers a free air displacement of 20 liters per min. Nearly vibrationless and noiseless, the Hyvac 2 is capable of pumping from atmospheric to ultimate pressure in approximately 5 min. and delivers a guaranteed ultimate vacuum of 0.1 μ. Pump is also more compact than former models. Pump and motor together measure only 10 by 15 in., with a height of 11 in. Other features of the Hyvac 2 include: oil level window; fast and convenient oil drain; and machined cast iron pulleys, individually balanced. Six motor arrangements to meet most voltage requirements are available. In addition to the unit with 115 v. 60 cycle motor, are models with 230 v., 60 cycle; 115 or 230 v. for 50 cycles; explosion proof and three-phase units. **Central Scientific Co.,** 1700 Irving Park Rd., Chicago, Ill.

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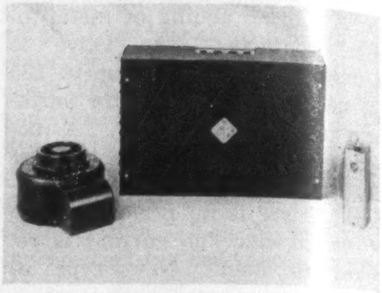

Motor Speed Controls

Particularly adaptable for use with small lathes, new 1 and 1½ hp motor speed controls are also suitable for a variety of control applications. Small drum controller is used in place of magnetic contactors as switching unit for forward, reverse, and stop operations. Controller and speed adjusting Variac® are separate from main chassis which can therefore be mounted in any out-of-the-way location. Dynamic braking resistor is included for use where quick stopping is required. **General Radio Co.,** 275 Massachusetts Ave., Cambridge 39, Mass.

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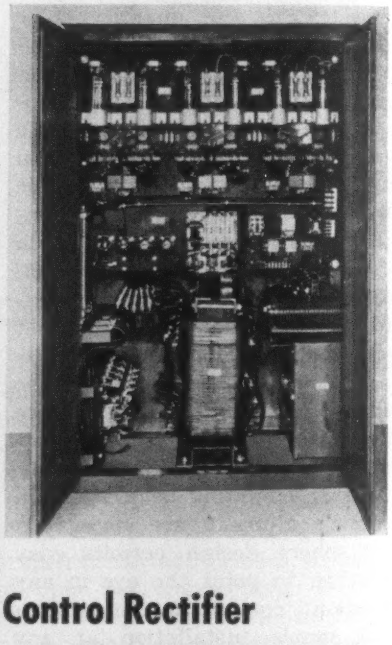
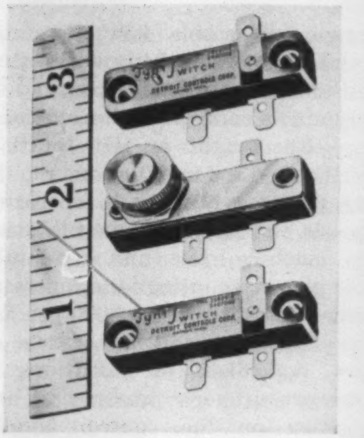


Control Rectifier

Variable speed motor drive consisting of a dc motor with an electronic rectifier power supply permits constant full load torque at speeds from minimum to maximum and has a speed range of 10 to 1. The electronic rectifier power supply is a grid controlled regulated variable armature supply and a fixed field supply. Six Xenon filled thyratron tubes accomplish the armature rectification and no other tubes or thermionic devices are used. The maximum armature current is limited by a control circuit which can be adjusted from 100 to 200 per cent of full load. Current cannot exceed the preset value even though the motor is stalled with the speed control in the maximum speed position. The pulse firing of the thyratron tubes eliminates electrical interference and assures stable control settings. Position of the two-way speed control lever determines the direction of rotation. Reversing is accomplished by a double pole mechanical and electrical interlocked reversing contactor in the armature circuit. The circuit is opened and closed electronically in the tube circuit. The unit, called the Theratrol, is designed for three-wire remote control. Device is available in 10 to 50 hp sizes, 450 to 3600 rpm. **Ther Electric Works,** Dept. ANC, 17 S. Jefferson St., Chicago 6, Ill.

Circle 476 on Inquiry Card



Snap Action Switch

Applicable in appliances, clock-timers, office equipment, automotive, electronic, vending machines, instrument and automation fields, new precision snap switch features compact construction. Fully enclosed unit, called the TyniSwitch, is 1⅝ inches long, 9/32-inch thick and 7/16-inch wide. Connecting elements in the spring release mechanism are eliminated; there is only one moving part. With a single stamping being used, positive snap action is provided. Force and movement are held to close tolerances, and the patented blade design produces a fast snap operation with positive maintenance of contact. TyniSwitch is available in four basic designs, varying in operating force from 3 to 12 oz in the pin operated models, and from 1½ to 12 grams in the wire operated models. **Detroit Controls Corp., TyniSwitch Dept.,** 800 Union Ave., Bridgeport, Conn.

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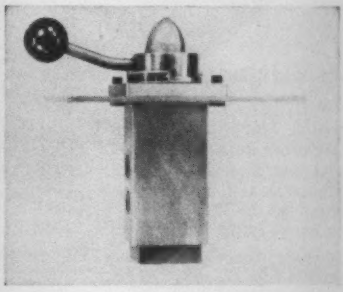

Flow Regulator

Designed for any system requiring a variable adjustment of the flow rate over a wide operating

"PIG-TAILORING"

. . . . *a revolutionary new mechanical process for higher production at lower costs. Fastest PREPARATION and ASSEMBLY of Resistors, Capacitors, Diodes and all other axial lead components for TERMINAL BOARDS, PRINTED CIRCUITS and MINIATURIZED ASSEMBLIES.*

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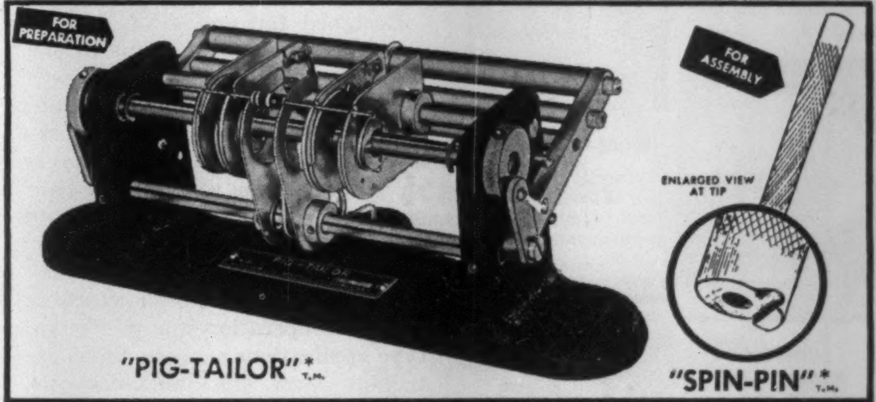

The "PIG-TAILOR" plus "SPIN-PIN" — Accurately Measures, Cuts, Bends, Ejects and Assembles both leads simultaneously to individual lengths and shapes — 3 minute set-up — No accessories — Foot operated — 1 hour training time.

PIG-TAILORING provides:

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2. Uniform marking exposure.
3. Miniaturization spacing control.
4. "S" leads for terminals.
5. "U" leads for printed circuits.
6. Individual cut and bend lengths.
7. Better time/rate analysis.
8. Closer cost control.
9. Invaluable labor saving.
10. Immediate cost recovery.

PIG-TAILORING eliminates:

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2. Long-nose pliers.
3. Operator judgment.
4. 90% operator training time.
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6. Broken leads.
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10. Haphazard assembly methods.

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Write for illustrated, descriptive text on "PIG-TAILORING" to Dept. A-6P

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Shown below is only a partial grouping of new AllenAir Catalogs. These, as well as others that make up the complete AllenAir line of Air Control Equipment, are spiral bound into a handsome master catalog for your convenience and easy reference.

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Air or Electrically Operated. Selection of 8 different models to meet your specific requirements. 1⅛" to 4" bore, up to 20" stroke in STOCK.

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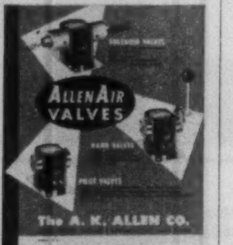
Single & Double Ended Cylinders

Complete range of sizes; all mounting styles.



Air Valves

8 page catalog illustrating complete line of solenoid, pilot and hand valves.

AllenAir SPRING RETURN Clamp
AC-1x1
$5.50
The A. K. ALLEN CO.

Spring Return Clamp

Universal mounting, (2) ⅛ N.P.T. air inlets, 1 brass hose connector.

AllenAir DIAL FEED TABLES
The A. K. ALLEN CO.

Dial Feed Indexing Tables

Selection of 3 different models.

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range, adjustable flow regulator has an aluminum body with internal parts of hardened steel and an adjustable control handle, available for either right or left rotation. Well suited for installations requiring frequent changes in operating speeds or throttling control during the machine cycle, unit is adapted for panel mounting and operates under pressures up to 3000 psi. Device maintains a constant rate of flow regardless of variations in pressure or back pressure at any position on the control handle. Flow regulators are designed to increase flexibility of hydraulic systems. **Waterman Engineering Co.,** 725 Custer Ave., Evanston, Ill.

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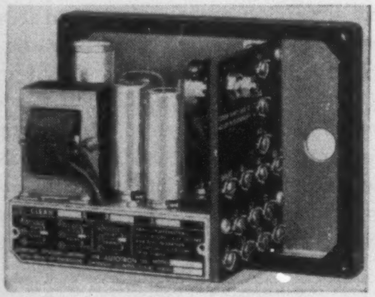
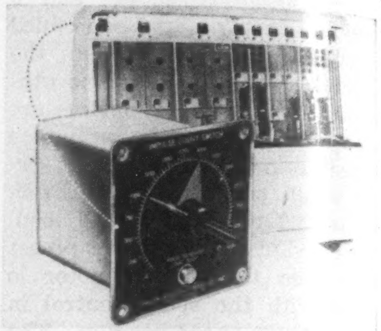


Photoelectric Control

Designed for protection as well as repetitive type applications where the phototube normally sees light, improved photoelectric control is called Model F1A. Plate relay energizes when light beam is on the phototube and all tubes are operating. Relay de-energizes when light beam is interrupted or when a tube filament fails or any tube loses emission, thus affording fail safe operation for protective type applications such as smoke detection, level and limit controls, safety controls, etc. Model F1A requires 5 ft-c. minimum light, 0.125 minimum phototube light time and 0.025 minimum phototube dark time. Plate relay contacts are double pole, double throw, rated at 8 amp, 115v ac, noninductive. Construction features include gasket-sealed, cast aluminum housing, chassis bolted to housing base, wiring diagram engraved on metal name plate, and permanent terminal identification. **Autotron Co.,** Box 722-RR, Danville, Ill.

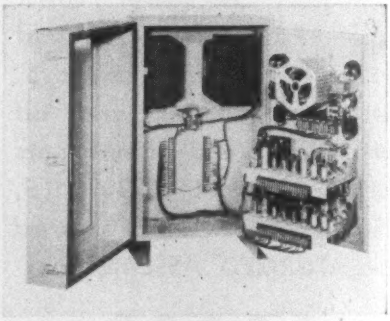
Circle 479 on Inquiry Card



Count Switch

Increased tool life, reduced tooling costs and fewer rejects are the result of new count switch. Device is set to the number of operations at which past experience indicates a tool should be changed. It trips a switch after a preset number of electrical impulses. Count switch thereby shuts down the machine automatically. In the illustrated application, count switches are mounted in a tool control unit manufactured by Royal Design & Mfg. Inc. A number of machines are controlled by this one unit which is installed near the machines. As an additional function, control unit provides storage space by spindle head or stations, for two complete sets of preset tools and adapter assemblies, ready for immediate use in the machine. **Hagen Mfg. Co.,** Moline, Ill.

Circle 480 on Inquiry Card

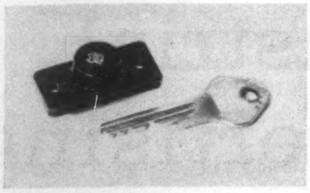


X-Ray Inspection

Built-in test panel for speedy adjustment of electronic circuits is one of the features of new x-ray inspection machine. Called the Hytafill®, the machine is used to automatically check under and over-fill levels of sealed, opaque containers on a conveyor system. Features of the Hytafill include:

Hinged door accessibility to internal mechanism to facilitate servicing, integral totalizing counters for recording under and over-fills, and line voltage stabilizer for smoothing out fluctuations of incoming line voltage. Capable of monitoring a liquid or free flowing solid with minimum density of 0.7, the x-ray inspection unit is used throughout the beer, carbonated beverage, canned milk and chemical industries. **General Electric Co., X-Ray Dept.,** 4855 Electric Ave., Milwaukee 1, Wis.

Circle 481 on Inquiry Card



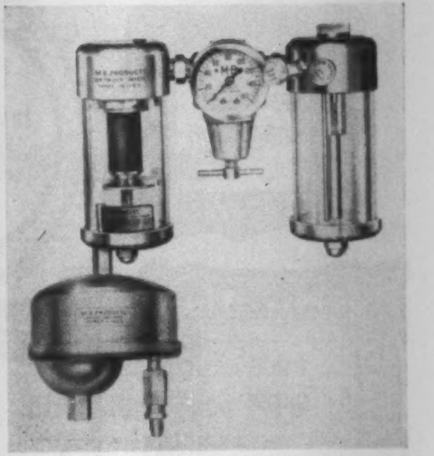
Power Transistors

Especially useful for power stages, new silicon power transistor makes possible the complete transistorization of many systems. Device is well suited for the output stages of servo amplifiers which convert small electrical variations into mechanical motion at a remote location. Through servo amplifiers, the signal from an automatic pilot can move the control surfaces of a large bomber. Type 970 silicon transistor weighs less than ¾-oz and is hermetically sealed in a disk approximately ½-inch in diameter by ½-inch high. Transistor is of the grown junction, n-p-n type construction, wherein layers of different conductivity silicon are produced in the large parent single crystal as it is grown. Power dissipation is 8.75 w maximum at 25C, with 3.5 w maximum at 100C. **Texas Instruments Inc.,** 6000 Lemmon Ave., Dallas 9, Tex.

Circle 482 on Inquiry Card

Air Line Protection

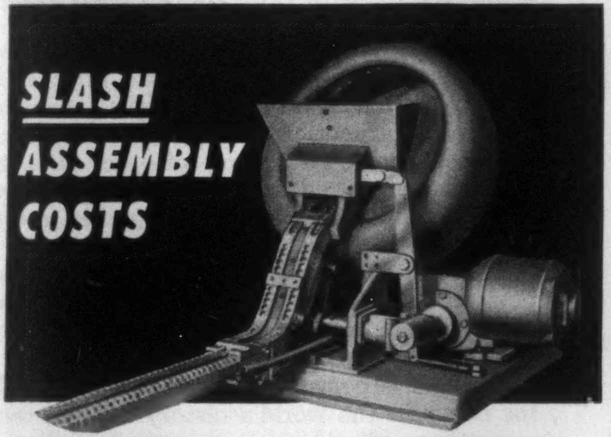
Filter, regulator and lubricator assembly are combined with automatic air trap to provide air line protection. Trap is installed in assembly by removing drain cock on filter and screwing trap into place. Regulator can pass large



volumes with an unrestricted flow and minimum pressure drop. Unit is self-bleeding and compact. Lubricator delivers desired volume of oil. Transparent bowl can be refilled without shutting off air supply. Air trap is automatic water ejector for all air line applications. It assures dry air in pneumatic systems at all times, eliminates costly downtime and assures preventive maintenance. **M-B Products,** 46 Victor Ave., Detroit 3, Mich.

Circle 483 on Inquiry Card

FEEDMATIC HOPPERS



Feedmatic Rotary Hoppers automatically deliver parts in proper position for assembly through attached feed tracks. By eliminating high cost hand operations, Feedmatics reduce assembly time—cut costs.

Use Feedmatics for high speed delivery of small parts to machine tools, grinders or special production machines—or for accurate sorting, counting and inspection operations. Feedmatic Hoppers are applicable to a wide range of parts: nuts, screws, bolts, pins, stampings, forgings, cylindrical shapes, etc. Write today, and send samples of your small parts.

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POWER SCREW DRIVER

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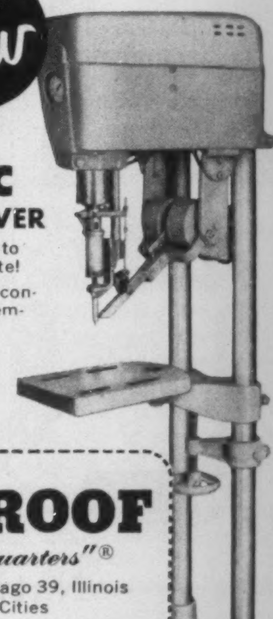
- Ideal for automation as well as conventional mass-production assembly lines!

Write for this today!
Model "400" Catalog Flyer



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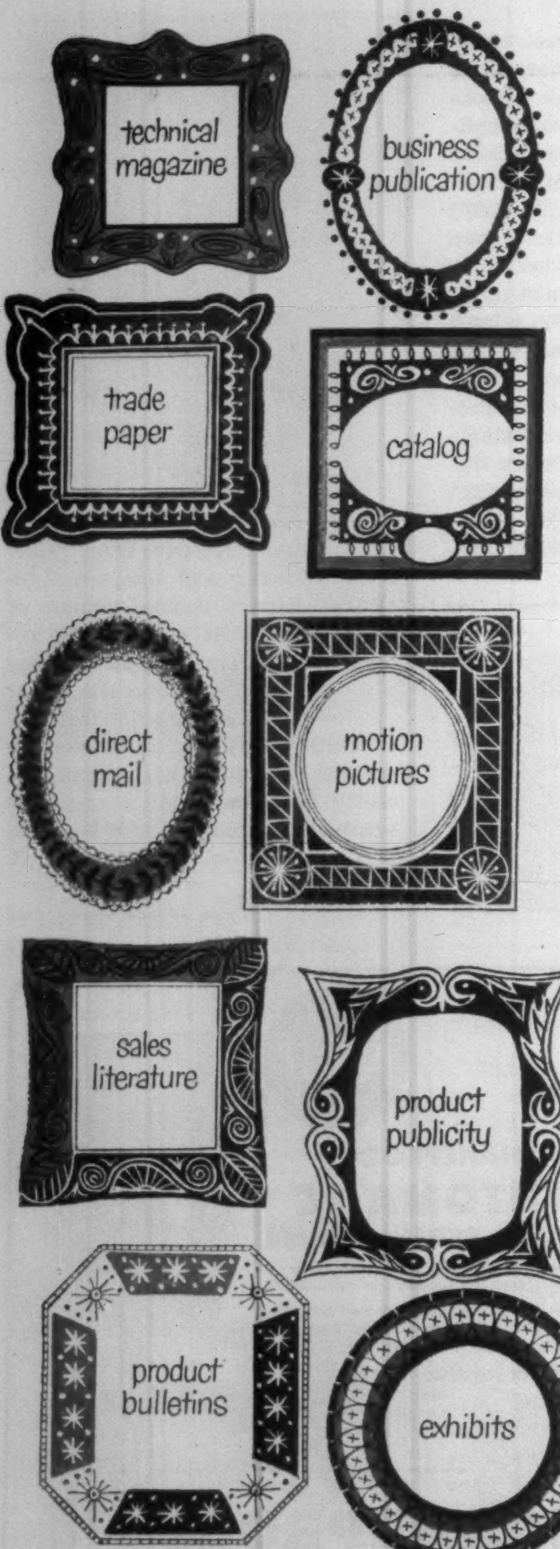

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catalogs and literature

Latest automation information. For copies use card page 17.

Hydraulic Cylinders & Valves

Pathon Mfg. Co., Pacific Ave., Cincinnati 12, *O.—36-page catalog*—Compact construction and increased strength are features of hydraulic cylinders described in catalog 22A. Designed primarily for oil service, cylinders which can be operated at either 1000 or 2000 psi are covered. Directional control valves and piston rods are also described and illustrated. Specifications and operating characteristics of devices are included.

Circle 484 on Inquiry Card

Continuous Gages and Controls

Pratt & Whitney Co. Inc., W. Hartford 1, *Conn.—28-page catalog* — Descriptions and illustrations of gages and control units for continuous processing of magnetic, nonmagnetic, metallic and nonmetallic materials are included in illustrated catalog. Contacting and noncontacting gages of magnetic, beta ray and x-ray types for measuring thickness, width, and rolling pressures are covered. Classifying control, automatic mill gage control, automatic size control, totalizer, and light signal control units are among control devices discussed.

Circle 485 on Inquiry Card

Bulk Materials Handling

Jervis B. Webb Co., Dept. NLP, 8951 *Alpine Ave., Detroit* 4, *Mich.*—12-*page bulletin*—Use of conveyors for handling such bulk materials as scrap, coal, ashes, sand, gravel, stone and chips is discussed in bulletin 455. Engineering data and installation information on several types of bulk handling conveyor systems are included.

Circle 486 on Inquiry Card

Press Controls

Danly Machine Specialties Inc., 2100 *S. Laramie Ave., Chicago* 50, *Ill.*—12-*page bulletin*—Equipment which is engineered to provide better operation of presses and press accessories, automatic feed devices, scrap cutters, etc. is described in new bulletin. Features of controls include convenient power outlets, single main control enclosure, fingertip control panel and hinged panels. Photographs illustrate safety and convenience features of control equipment.

Circle 487 on Inquiry Card

Displacement Pumps

Tuthill Pump Co., 939 *E.* 95th *St., Chicago* 19, *Ill.*—12-*page bulletin* — Line of rotary, internal gear, positive displacement pumps for use in handling noncorrosive liquids with lubricating qualities is the subject of bulletin 102. Series C pumps are available in eight sizes ranging in capacities from ½ to 200 gpm and pressures up to 100 psi. Dimensions, part numbers and photographs of several models in the line are included.

Circle 488 on Inquiry Card

Automatic Transfer Switches

Automatic Switch Co., 391 *Lakeside Ave., Orange, N. J.*—16-*page booklet*—Ten factors which should be considered in the selection of automatic transfer switches are listed in booklet 596. Photographs and brief explanations indicate why each of these factors is a necessity in switch selection. Application photographs illustrate automatic transfer switches being used to protect generators and to insure operation of key valves and control panels.

Circle 489 on Inquiry Card

Twin Contact Relays

Stromberg-Carlson Co., Div., General Dynamics Corp., 100 *Carlson Rd., Rochester* 3, *N. Y.*—24-*page catalog*—Designed for electromechanical switching applications, line of twin contact relays is the subject of illustrated catalog. Relays are categorized into five types. Fast acting, slow acting, snap-action switch, plug-in, and vibrator models in one type are covered. Specifications, ordering information, and illustrations of relay mountings are included.

Circle 490 on Inquiry Card

Alternating Tube Flow

Statham Laboratories Inc., 12401 *W. Olympic Blvd., Los Angeles* 64, *Calif.* — 8-*page bulletin* — Instrument Notes No. 30 covers the subject of alternating flow of fluid in tubes. Means are given for deriving accurate flow impedance values, even with ducts shaped so that rigorous mathematical treatment is impossible. Graphs illustrating flow resistance and velocity profiles are included.

Circle 491 on Inquiry Card

Air & Gas Compressors

Ingersoll-Rand Co., 11 *Broadway, New York* 4, *N. Y.*—8-*page bulletin*—Range of centrifugal and reciprocating compressor units with electric, steam, gas and diesel power for all pressures from deep vacuum up to 35,000 psi and capacities up to 165,000 cfm. are covered in bulletin 3132-A. Illustrated in operation are compressors in refining, antibiotics manufacture, oil well repressuring, ammonia and chemical production, and plastics manufacture. Units handle chlorine gas, hydrogen, ammonia, hydrogen chloride, etc. Fifteen basic types of compressors are briefly described and illustrated.

Circle 492 on Inquiry Card

Process Control Devices

Barnes Engineering Co., 30 *Commerce Rd., Stamford, Conn.*—8-*page bulletin*—Infrared radiometers for remote temperature measurement, infrared detectors, refractometer for controlling purity of process streams, infrared sources and detector preamplifiers are electro-optical instruments covered in bulletin. Photographs and operating characteristics of instruments are included.

Circle 493 on Inquiry Card

Solenoid Valves

Atkomatic Valve Co. Inc., 545 *W. Abbott St., Indianapolis, Ind.*—24-*page catalog*—Line of electrically operated, two-way solenoid valves for air, gas, steam and liquid flow control is described in catalog 200. Among valve types covered are: General purpose, pilot operated bronze valves for ¼ to 3-inch pipe sizes, and all stainless steel valves for ¼ to 1½-inch pipe sizes, with pressures ranging from 1 to 1500 psi. Dimensions, specifications, pressures and applications of solenoid valves are given.

Circle 494 on Inquiry Card

Fluid Power Controls

Carter Controls Inc., 2800 *Bernice Rd., Lansing, Ill.—42-page catalog*—Line of air and hydraulic cylinders, piston rods and air valves is discussed in new catalog. Clamp type cylinders are used in clamping, die stripping and spring return motions; all control devices are designed for integration into automatic equipment. Specifications, photographs and application information on the controls are included.

Circle 495 on Inquiry Card

Fine Pitch Gears

PIC Design Corp., 160 *Atlantic Ave., Lynbrook, L.I., N.Y.—26-page catalog*—Line of nylon, phenolic, stainless and aluminum spur and helical gears in fine pitch series available from stock are covered in catalog 8. Fine pitch racks, pulleys, belts, oilless bronze bearings, mounting plates for bearings and components, drum dails and vernier sets, and precision differential kits are among the other items covered.

Circle 496 on Inquiry Card

V-Belt Drives

Allis-Chalmers Mfg. Co., 1205 *S. 70th St., Milwaukee, Wis.—36-page catalog*—Used in machine tool, mining, power generation, chemical, paper making, petroleum, food processing and automotive industries, multiple V-belt drives are the subject of catalog 20E8297. Evolution of standards in engineering these drives, information on how to engineer them, and tables covering sizes, serial numbers and pitch lengths are included. Photographs illustrate the drives being used in different applications.

Circle 497 on Inquiry Card

Reciprocating Hearth Furnaces

American Gas Furnace Co., Elizabeth, N. J. — 12-page bulletin — Designed for continuous production bright hardening, light case carburizing, Ni-Carb process of ammonia-gas carburizing and other heat treating processes, Series 200 controlled atmosphere reciprocating furnaces are the subject of bulletin 850.10. Furnaces feature automatic temperature control, atmosphere gas control and gas generators, automatic quenching tanks, automatic rotary feeding hopper and automatic washing and tempering equipment. Photographs and specifications of several models are included.

Circle 498 on Inquiry Card

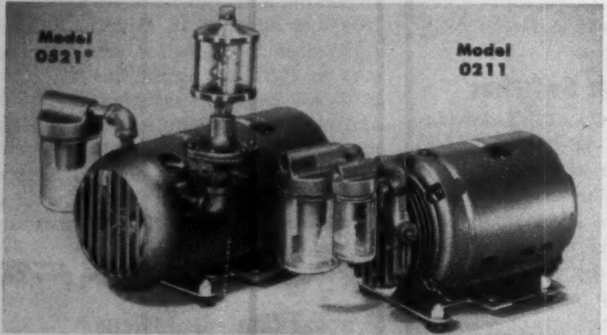
Special Application Bearings

Industrial Tectonics Inc., 3684 *Jackson Rd., Ann Arbor, Mich.—32-page catalog*—Precision, antifriction bearings designed for special applications are discussed in catalog AFB-1. Dimensions and load ratings are given for single row, duplex and double row radial and angular contact bearings. General bearing requirements for special designs, high and low temperatures, corrosion resistance, nonmagnetic properties, electrical conductivity, and insulating features are discussed in the catalog.

Circle 499 on Inquiry Card

Digital Measuring

Non-Linear Systems Inc., Del Mar Airport, Del Mar, Calif. — 28-page catalog—Versatility in automatic precise measurement is provided by line of digital measuring instruments described in catalog 356. Instruments


Model 0521*
Model 0211

You get 10 big Integral-Motor-Pump advantages in these two NEW types (three models) of

GAST rotary vane AIR PUMPS

Model 0211
1/6 hp, to 1.3 cfm, 25 psi or 27" vac.

Model 0321
1/4 hp, to 2.2 cfm, 25 psi or 28" vac.

Model 0521
1/3 hp, to 3.8 cfm, 20 psi or 28" vac.

*0321 similar in appearance.

1. Latest type G.E. "Form G" motors.
2. More compact than other pumps.
3. Total weight reduced 1/3—cuts shipping costs.
4. Motor mounting time and labor eliminated.
5. Simple, trouble-free rotary-vane design.
6. Vanes take up their own wear automatically.
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8. Improved appearance—smoother exterior.
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10. Forced air fan cooling on Models 0321 & 0521.

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Original Equipment Manufacturers for Over 25 Years

GAST ROTARY
- AIR MOTORS TO 4 H.P.
- COMPRESSORS TO 30 P.S.I.
- VACUUM PUMPS TO 28 IN.

See Our Catalog in Sweet's Product Design File

Circle 600 on Inquiry Card

TIPP "Cable-Way"® Conveyors
Cable conveyors since 1938

VERSATILE ATTACHMENTS
Simple change from locked to swinging position — many hanger designs available.

Track is 2"x2"x¼", suspended by ⅝" threaded hanger rods.

3 trolley capacities: 80-150 & 250 lbs.
Same trolley — change wheels only.

Low cost, easy to move, lightweight

Rugged all-bolted construction — easy to rearrange. Propelled by a driving corner sprocket (cast iron) which engages in drive lugs (steel) in pitch on a continuous cable. New catalog available.

Write to Tipp Manufacturing Co., Tipp City 3, Ohio

Compact 180° idle corners of cast aluminum 15¼", 22$\frac{15}{16}$" or 30$\frac{9}{16}$" dia.

Vertical dip—standard 60° or 90° included angle. Charts showing work clearances at dips and inclines available.

INVENTORY IN MOTION WITH . . . Tipp . . .
A FULLY ENGINEERED PRODUCT

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covered include digital voltmeters, digital ohmmeters, digital readouts, data reduction systems, peak reader systems, digital recording systems, ac-dc converters and binary decimal converters. Photographs and specifications of numerous models are given along with application information.

Circle 500 on Inquiry Card

Volumetric Metering

Hetherington & Berner Inc., 701-745 *Kentucky Ave., Indianapolis* 7, *Ind.—12-page bulletin*—Designed for the batching of liquids, new automatic volumetric metering system which is adaptable to measuring problems involving gallons, barrels, or tank cars is discussed in bulletin FL-56. Fluidometer system includes an automatic resetting control head, a meter of suitable size, type and material, and a control valve. Photographs illustrate typical all-jacketed direct control system, remote control system, dual valve system, multivalve system and jacketed flow metering system. Four typical installations of Fluidometer are also shown.

Circle 501 on Inquiry Card

Automatic Control System

Automatic Control Co., 1005 *University Ave., St. Paul, Minn.—8-page bulletin* — New telemetering system which is designed especially for industrial and municipal water and sewage systems is the subject of bulletin 9100. Used on remote pumps, valves, gates, tanks and reservoirs, the system provides for indication, recording, alarm and control. Five basic models in the transmission control system and primary sensory devices are discussed.

Circle 502 on Inquiry Card

Drive for Fork Lift Trucks

Towmotor Corp., 1226 *E.* 152nd *St., Cleveland* 10, *O.—8-page bulletin* — Automatic transmission called the TowmoTorque drive, designed to speed up fork truck operations, and available on most company models, is the subject of illustrated bulletin. Hydraulic torque converter, duplex directional clutch and transmission gear elements are described and illustrated. Also covered are the oil supply and control systems of the unit.

Circle 503 on Inquiry Card

Industrial Ovens

Lanly Co., 750 *Prospect Ave., Cleveland, O.—16-page booklet*—Discussion of ovens for industry which feature direct fired air heaters, balanced, recirculating heating systems, advanced instrumentation and insulated metal panels is given in booklet 520. Numerous application photographs illustrate foundry, finishing and heat treating ovens and furnaces, cabinet type ovens, ceramic and chemical dryers and miscellaneous types.

Circle 504 on Inquiry Card

Magnetic Valves

Magnatrol Valve Corp., 67 *Fifth Ave., Hawthorne, N. J.—20-page booklet*—Line of solenoid valves used to control flow of water, oil, brine, chemicals, air solvents, gas and steam is discussed in new booklet. Photographs and specifications of 13 different models are included, with data on strainers and explosion proof solenoids also given. Comparative tables of fluid discharge and friction drop complete the booklet.

Circle 505 on Inquiry Card

Electric Fork Trucks

Baker-Raulang Co., Cleveland 2, *O—12-page bulletin*—Maneuverability, ease of maintenance and increased operator convenience are features of two new electric fork trucks. Bulletin 1324-C covers 4000-lb truck; bulletin 1325-D discusses 6000-lb truck. Performance specifications, dimensions and details on controls and construction of trucks are given.

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with STANDARD TOOL "Know-how"
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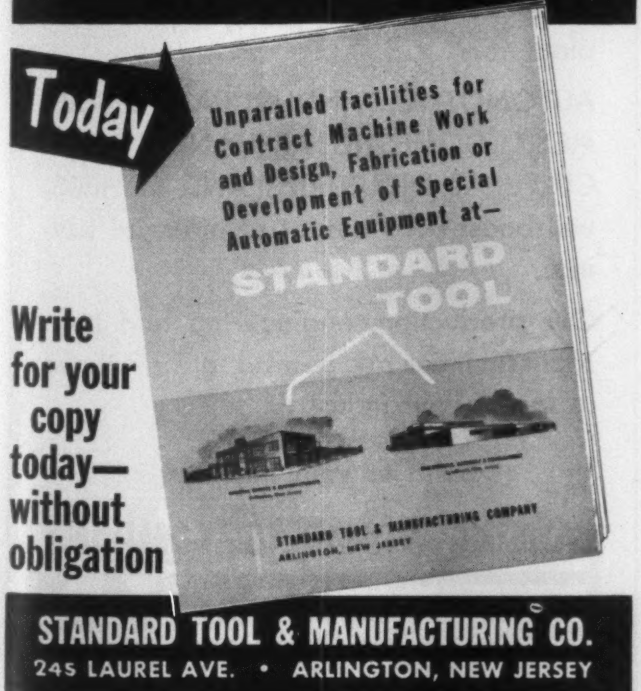
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Circle 602 on Inquiry Card

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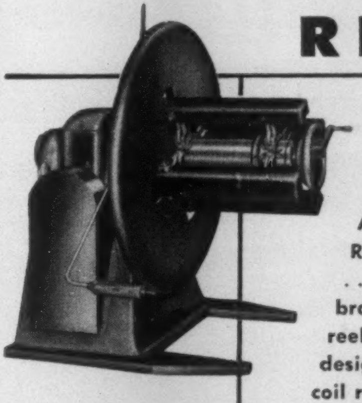
LITTELL REELS



Whether you feed stock from 100 pound coils or 40,000 pound coils, there is a Littell Automatic Centering Reel to meet your needs . . . motor driven, electric brake and plain brake reels. Every Littell Reel is designed for swift, safe coil replacement and smooth, *controlled* uncoiling. All models combine smooth running accuracy with rugged construction that assures *extra* years of dependable service.

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Circle 603 on Inquiry Card

Double Seaming Machines

E. W. Bliss Co., 50 Church St., New York 7, N. Y.—12-page bulletin —Designed for medium and high speed can making lines, double seaming machines are the subject of Catalog 36B, Section 5. Semiautomatic round can seamers, square and irregular shaped can seamers, automatic body feeders, semiautomatic square can seamers and semiautomatic side seamer are illustrated and described. Design and construction features and specifications of machines are given.

Circle 507 on Inquiry Card

Electronic Flow Meters

Hays Corp., Michigan City, Ind.—12-*page bulletin*—Designed for measurement of differential pressures; liquid level; fluid, gas, air or steam flow; temperatures and pressures, electronic flow meters are discussed in bulletin 55-1074-222. Choice of several mercury-less transmitters is available with the flow meters. Transmitters, transmission system, receiver and integrator are described and illustrated.

Circle 508 on Inquiry Card

Pallet Loading

J. W. Greer Co., Wilmington, Mass. 8-*page bulletin*—Semiautomatic machine which makes pallet loading fast, safe and inexpensive for any production or packing line is discussed in bulletin entitled "The Palletizer." Six photographs illustrate sequence of operations of the machine. Capacity chart and general specifications are also included.

Circle 509 on Inquiry Card

Air Cylinders

Miller Fluid Power Co., 2040 *N. Hawthorne Ave., Melrose Park, Ill.*—8-*page bulletin*—Complete line of nonrotating air cylinders for heavy duty operation is described in bulletin A105K. Cylinders are designed to speed production, lower cost, lighten labor and equalize quality. New models in line are described and illustrated, with data on high temperature operation included.

Circle 510 on Inquiry Card

Performance Rated Motors

Century Electric Co., 1806 *Pine St., St. Louis* 3, *Mo.*—12-*page bulletin*—Line of small motors which are designed for operation from 1 to 30 hp is the subject of illustrated bulletin. Motors with following torque characteristics are available: Normal starting torque for friction and inertia loads, high starting torque for starting full loads from break-away, and high starting-high slip torque for starting impact and shock loads from breakaway. Interchangeable mounting dimensions with other makes are given in chart form.

Circle 511 on Inquiry Card

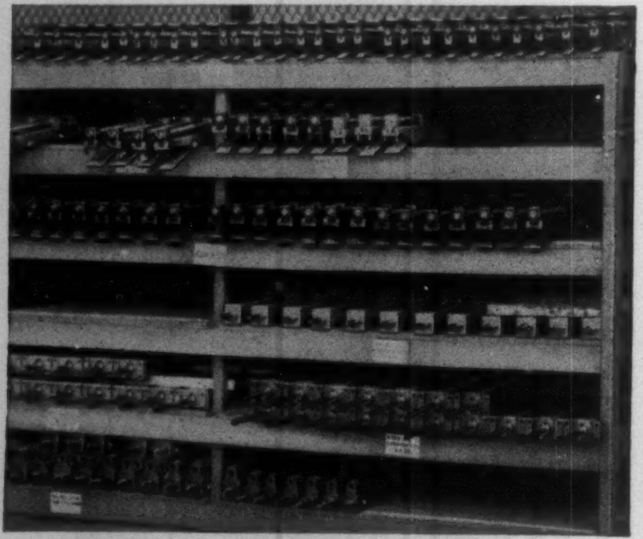
Visual Alarm Systems

Autocall Co., Shelby, O.—32-*page catalog* — Typical conditions which may be indicated by alarm systems include liquid level, electromechanical movement, temperature, pressure or vacuum, position, weight or force, presence of an opaque body, rotary movement, and presence or absence of light. Various types of annunciators and their applications are discussed and illustrated in catalog, along with control equipment and supervisory relays.

Circle 512 on Inquiry Card

Cooling Equipment

Niagara Blower Co., 405 *Lexington Ave., New York* 17, *N. Y.*—8-*page bulletin*—Pneumatic control systems for automatic machine operation, instrument operating systems, power applications to hand and machine tools, paint spray systems and sand blasting are among the typical plant applications which may make use of



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Replacement jaws for Sahlin Iron Hands are now carried in stock for fast off-the-shelf delivery. Orders are promptly filled, often on the same day. Eight standard types are available: will design and build specials on request. To further speed service, write or phone complete information, including Model No. of the Iron Hand and description of jaw type.

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Circle 605 on Inquiry Card

drying equipment called the After Cooler. Bulletin 130 covers uses of unit which is a self-contained method equal to both shell and tube cooler and cooling tower. Photographs illustrate After Cooler being applied to air liquefaction systems.

Circle 513 on Inquiry Card

In-Line Desurger

Westinghouse Air Brake Co., Industrial Products Div., Wilmerding, Pa.—4-page pamphlet—Designed to eliminate damaging surge, pump pulsation and water hammer shock in liquid lines, new desurger unit is covered in pamphlet A6-118.01. Photographs illustrate typical applications of the unit, with graphs indicating results obtained through their use.

Circle 514 on Inquiry Card

Hardness Tester

Wilson Mechanical Instrument Div., American Chain & Cable Co. Inc., 230 Park Ave., New York 17, N. Y.—4-page pamphlet—Up to 1000 pieces per hour are automatically processed by hardness tester described in pamphlet DH-361. Optional testing procedures—manual, semiautomatic and fully automatic—control features and feed mechanisms for the unit are discussed.

Circle 515 on Inquiry Card

Downhill Pumping

Milton Roy Co., Station M, 1300 E. Mermaid Lane, Philadelphia 18, Pa.—4-page pamphlet—Line of controlled volume pumps for downhill metering of liquids and gases is covered in pamphlet 855. Specifications, capacities and features of the units which pump from high pressures to lower discharge pressures are included.

Circle 516 on Inquiry Card

Electronic Tubes

Chatham Electronics Div., Gera Corp., Livingston, N. J.—4-page pamphlet—Rectifiers, twin power triodes, voltage regulators and reference tubes, decade counters, thyratrons and other electronic tubes designed for commercial, industrial and military applications are discussed and illustrated in new pamphlet.

Circle 517 on Inquiry Card

Bale Sealer

J. L. Ferguson Co., Route 52 at Republic Ave., Joliet, Ill.—4-page pamphlet—Designed to automatically fold, glue, seal and compress paper bales, new bale sealer is described in illustrated pamphlet. Information on the range, speed, construction features and dimensions of the unit are included.

Circle 518 on Inquiry Card

Fluid Power Devices

Rivett Lathe & Grinder Inc., Brighton 35, Boston, Mass.—4-page pamphlet—Line of valves, cylinders and power units is covered in new pamphlet. Cross-sectional diagrams of cylinders and valves and photographs of various models in line of air and hydraulic components are included.

Circle 519 on Inquiry Card

Ratchet Drive Lubricator

"Service," Bijur Lubricating Corp., 151 W. Passaic, Rochelle Park, N. J.—2-page pamphlet—Fully automatic lubrication is provided for small machines or mechanisms by ratchet drive lubricator described in Reference Sheet 55B. Features of the unit such as the pump cycle, gear reductions, ratchet drive mechanism and instant feed button are illustrated.

Circle 520 on Inquiry Card

Work Positioning

Erickson Tool Co., E. 23rd & Hamilton Ave., Cleveland 14, O.—4-page pamphlet—New device called the Master Spacer which accurately indexes work for a variety of machining jobs is described in pamphlet. Included are dimensional diagrams, cutaway view of the unit, and information on specific applications which include milling, drilling and inspection.

Circle 521 on Inquiry Card

3 WAY Flow "FLEX-A-SWITCH"
LEFT and RIGHT and THROUGH
2 WAY Flow
• LEFT & THROUGH
• RIGHT & THROUGH

ROLLERS are concentric at any setting to assure positive line of travel without guard rails. Can be used with curves and straight sections to distribute work in production or warehouse handling. Standard 11½"; 15"; 18" conveyor widths.

Remote or manual control. Remote control illustrated at left.

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MFRS. OF WHEEL & ROLLER GRAVITY & LIVE ROLLER CONVEYORS • POWER BELT CONVEYORS • SWITCHES • ACCESSORIES

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For more than 20 years ESS instruments have performed consistently, under rigid conditions. Each unit is designed to do a specific job...monitoring **smoke, turbidity, dusts, industrial gases** and **color.**

Here is a complete line of dependable and rugged instruments engineered to meet your problems of recording—indicating—controlling.

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At any stage of production Ess instruments are standard equipment.

ELECTRONIC INSTRUMENTS and CONTROLS for INDUSTRY
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Circle 607 on Inquiry Card

Deflashing Plastics

Wheelabrator Corp., 1109 S. Byrkit St., Mishawaka, Ind.—4-page pamphlet—Automatic pellet deflashing of molded plastic parts and laminated plastic items is the subject of new pamphlet. Four illustrated case histories show how the process works and give performance data.

Circle 522 on Inquiry Card

Industrial Time Controls

Paragon Electric Co., Two Rivers, Wis. — 4-page pamphlet — Preset interval timers, cycle repeaters, automatic reset timers and other time controls are discussed in Form No. 5505. Operating characteristics, specifications and photographs of the various control devices are included.

Circle 523 on Inquiry Card

Automatic Plating Machine

Udylite Corp., Detroit 11, Mich.—4-page pamphlet—Ideal for handling cadmium and zinc plating, new automatic plating machine called the Cyclemaster also is used for copper-nickel-chrome plating processes. Photographs illustrate design features of the machine, and construction details are listed.

Circle 524 on Inquiry Card

Planning Aids

Repro-Templets Inc., Oakmont, Pa.—4-page pamphlet—Line of colored templets and continuous layout tapes developed for color coding master layouts is described in new pamphlet. Types and colors of templets and tapes available are listed, with price information also included.

Circle 525 on Inquiry Card

Production Control Unit

Earl L. Thompson Mfg. Co., 1300 Hilton Rd., Ferndale, Mich.—2-page pamphlet—Two-speed, cam driven, multiple circuit hydraulic power and sequence control unit for actuating feeds, chucking or clamping, loading and unloading, gaging, etc., is described and illustrated in pamphlet. Features, applications, and cutaway drawing which shows operating principle of the unit are included.

Circle 526 on Inquiry Card

Overhead Trolley Conveyors

Rapistan-Keystone Inc., 21750 W. Eight Mile Rd., Detroit 4, Mich.—4-page pamphlet—Features and uses of overhead trolley conveyors in transportation, processing, storage, assembly and other phases of production and warehousing are covered in illustrated pamphlet R-K 55. Accessory equipment is also illustrated and described.

Circle 527 on Inquiry Card

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Los Angeles, Calif.
By JOHN T. MILEK and DONALD V. BLACK

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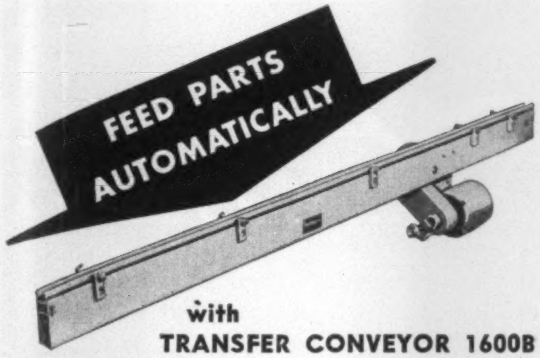

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Look at These Features:

COMPACT UNIT—with a conveyor frame only 1¾″ wide it handles parts from ¼″ to 1½″ in diameter and various lengths.

EASY SPEED ADJUSTMENT—Variable speed drive permits setting speed to match that of the production machines which it serves.

MADE IN VARIABLE LENGTHS—Standard Model illustrated is 62½″ long but other sizes are available.

POWERED by ¼ H.P. 3-phase 220/440 Volt Motor.

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"Analog Computer Solutions for Feedback Systems"

by Charles H. Single

Presented at the Fall Conference, American Society of Mechanical Engineers, San Francisco Section, San Francisco, October 28, 1955

Data File 123

Presents typical analog computer techniques in feedback system design. Cites as examples methods used in the design of a nuclear reactor power plant, and of a petroleum fractionating tower system.

Covers the capacity, limitations and practical applications of analog computers to the solution of feedback system design problems.

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AUTOMATION abstracts

AUTOMATIC GAGING FOR MACHINE TOOLS

By W. C. MULLIN
Gage Sales Engineer
Pratt & Whitney Co. Inc.

TO ENGINEERS who are directly concerned with machine tools the most productive use of automatic gaging is an important objective. To obtain its maximum benefits, it is necessary to know the types of systems now available and to decide how each should be utilized; in other words, to select the form of automatic gaging that is best for a particular situation.

The engineer or firm that is giving serious consideration to automatic or machine control gaging is doing so only because it can contribute such definite, tangible benefits, as lower costs, high production, or greater efficiency. Regardless of their relative importance, attaining one or more of these benefits requires the evaluation of alternatives. Assuming, then, that automation gaging represents a worthwhile goal, let us see how we should select a method to achieve it.

We may choose for automation gaging either what is called "in-process" gaging or, as an alternative, "post-process" gaging. By in-process gaging we simply mean gaging the part or process as machining operations are being performed. By post-process gaging we mean gaging the part or process after operations are performed. The major difference between these methods is that in in-process gaging we are able to prevent bad parts or scrap from being produced and, in post-process gaging, we act to separate the bad parts from the good, permitting the good parts to continue in the manufacturing process.

In-Process Gaging

Let us first consider in-process gaging. In this method, Fig. 1, the gaging unit is ordinarily mounted directly on the machine in such a manner that it contacts the part while it is being made. The schematic diagram shows a simplified application of automatic in-process gaging as applied to a lathe, grinder, or similar machine. In this operation, the gage circuit, amplifier and motor supply feedback signals to the cross slide that is determining the size of the piece being machined. If the workpiece should be oversize, for example, the amplifier would receive a voltage which, through the motor, would turn the feed screw until this voltage again became zero. The intelligence fed back continuously into the machine controls causes the machine to make parts that are within prescribed tolerance.

An ideal arrangement would be to have a series of machines in an integrated line, with each machine performing a particular operation. At each of these machines might be a gage to monitor that particular operation and thereby prevent that machine from making bad parts. This would insure that the efficiency of the line would remain high and that only good parts would be transferred from one operation to the next. The major problem here, however, is the fact that in-process gaging as such is not applicable to all types of machining operations. Generally, it is most suitable for ID and OD grinding, ID and OD turning, and various types of surface or flat grinding.

Post Process Gaging

To return to post-process gaging—our second alternative—there are two methods of machine control which are normally used. The first is similar to the method just discussed in that tooling on the machine is adjusted after each part is gaged and before the next is

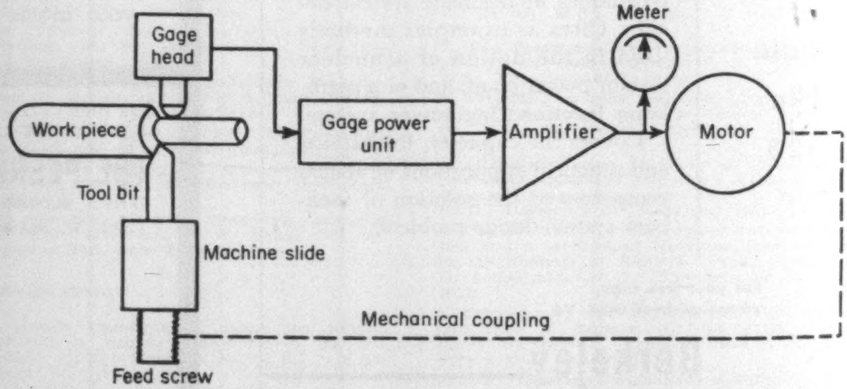
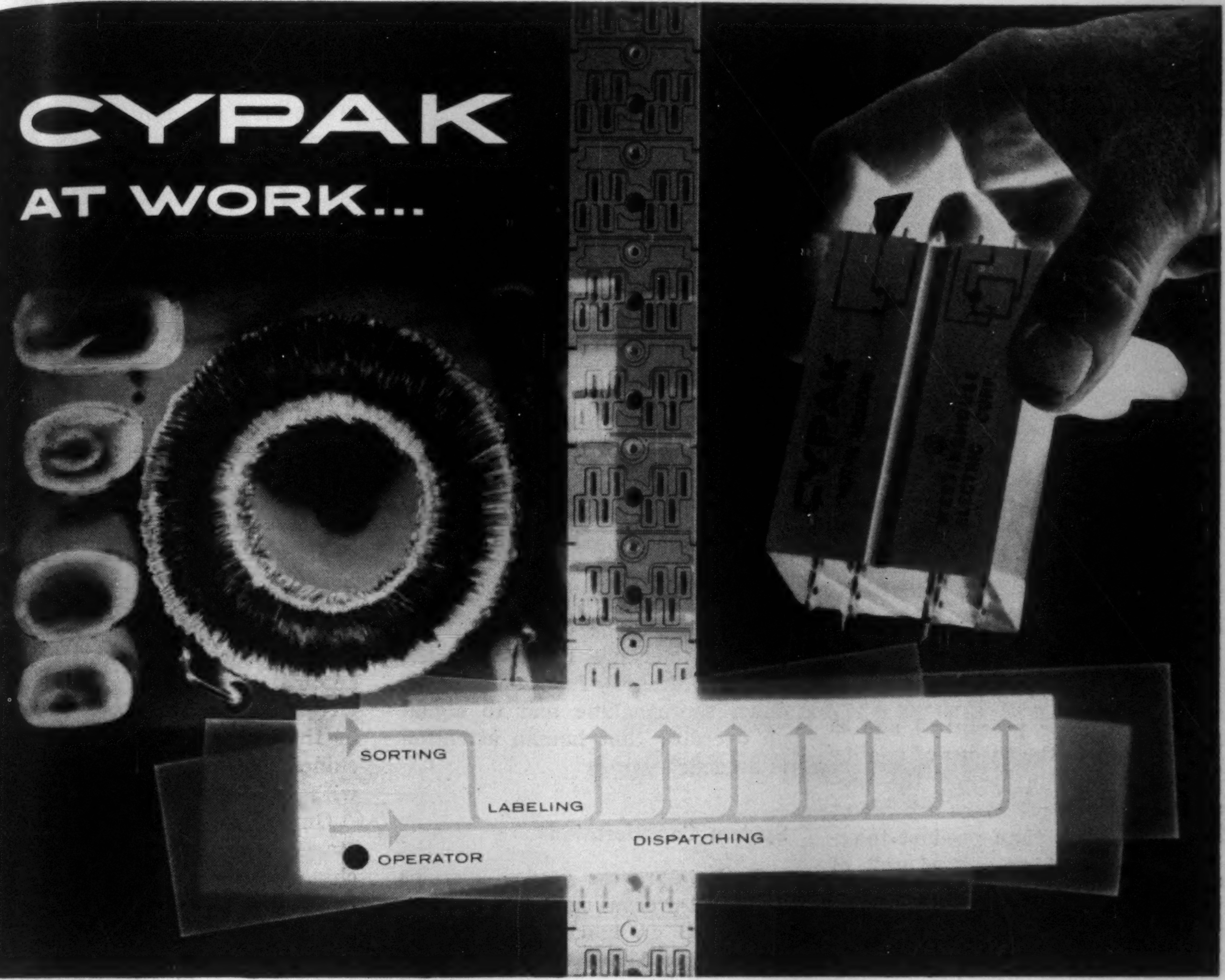


Fig. 1—Schematic diagram of automatic in-process gaging system for applications such as a boring machine or lathe. The gaging unit measures the workpiece as it is being made.



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made. This is termed a continuous feedback control system.

A representative application is the proportional control of a grinder, *Fig.* 2, in which it is not always practical to measure the workpiece as it is being sized. Instead, the part just ground is used to reset the machine for the following piece. The gage measures the piece that was just ground by the position of the switch that stopped the grinder cycle. If this size is correct, no error voltage will be applied to the motor to reposition the switch. If, however, the size is incorrect, the motor will run in the appropriate direction to do two things: (1) Find a new position on the slide-wire to reduce the error signal to zero, at which time action stops; and (2) reposition the switch which controls the feed stop on the machine.

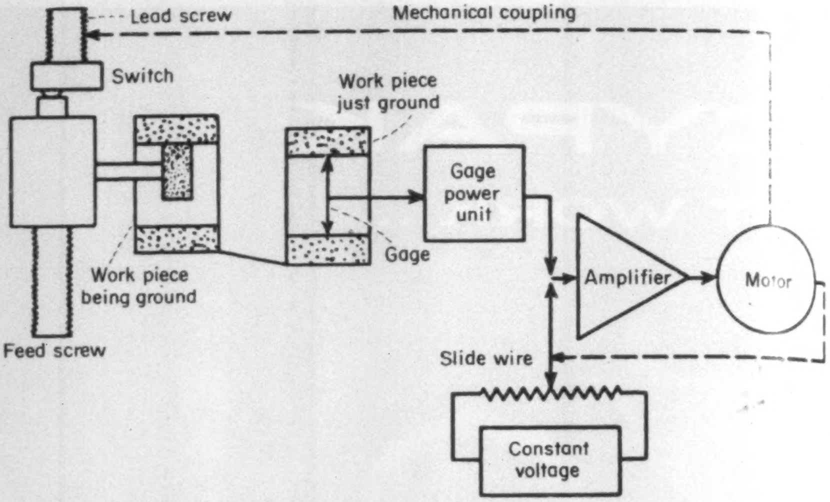
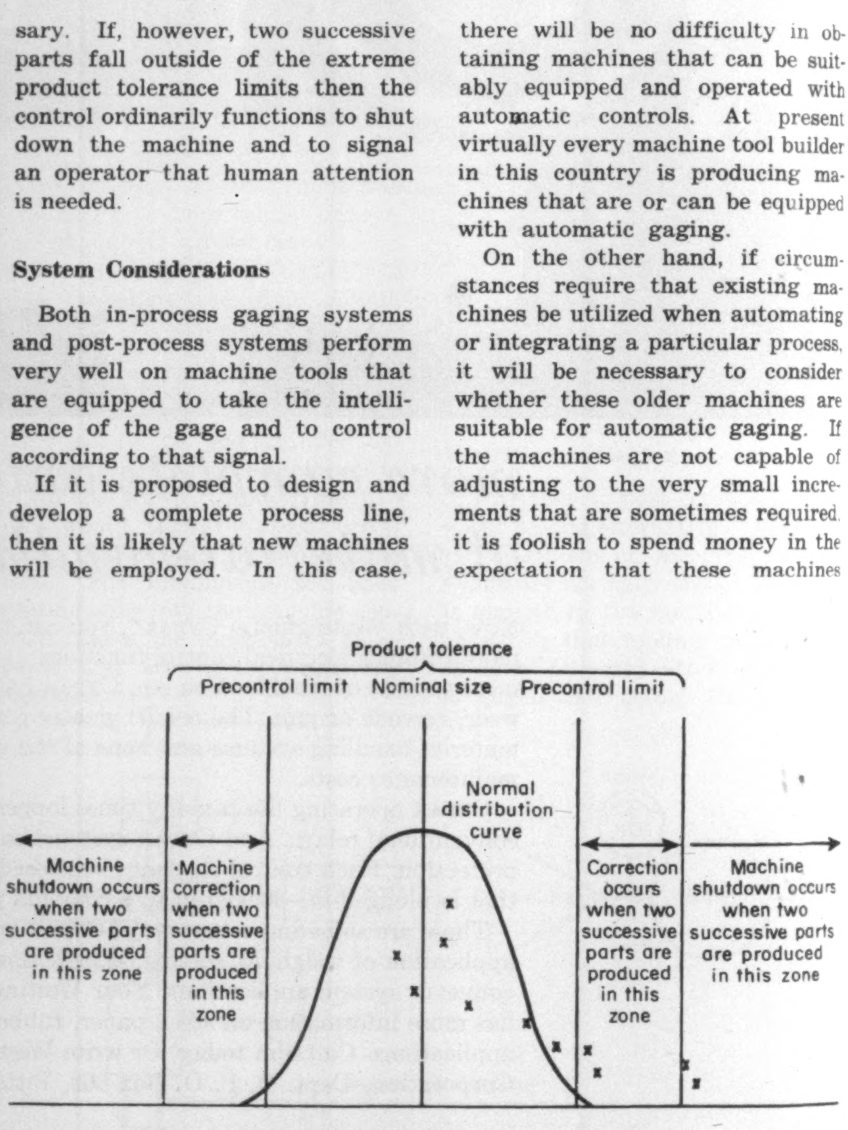


Fig. 2—Schematic diagram of post-process gaging demonstrated on a grinding machine. The part being ground will be measured after grinding and this measurement used to reset the grinder for the following piece.

The second method of control is what is normally referred to as zone control or precontrol and is tied closely to the theory of quality control. In this system the precontrol or control zones are set at something less than product tolerance; the machine control unit of the gage is set up as is shown in *Fig.* 3. The centerline represents the nominal size of the part and the two intermediate lines — one plus, the other minus — represent the precontrol zones. The two extreme outside lines define actual product tolerance.

In operation, each part is fed into the gage as it is produced by the machine, and the gage then measures the dimensions in question. If these dimensions fall within precontrol tolerance limits no correction is necessary, the part is passed as a good part and the machine receives a signal to permit production of a second part. This sequence continues as long as all of the parts are falling within the two precontrol zones. If, however, two successive piece parts fall outside of the precontrol zones. either on the high side or the low side, then an impulse transmitted from the gage to the machine produces an appropriate tooling correction to bring the part back within tolerance. Ordinarily this will cause several piece parts to be made within the precontrol zone before a second correction is necessary. If, however, two successive parts fall outside of the extreme product tolerance limits then the control ordinarily functions to shut down the machine and to signal an operator that human attention is needed.



Zone control for post process gaging

Fig. 3—Relationship of probability curve to zone control. Centerline represents nominal size; lines almost including the entire distribution curve are control limits; and extreme lines represent part tolerances.

System Considerations

Both in-process gaging systems and post-process systems perform very well on machine tools that are equipped to take the intelligence of the gage and to control according to that signal.

If it is proposed to design and develop a complete process line, then it is likely that new machines will be employed. In this case, there will be no difficulty in obtaining machines that can be suitably equipped and operated with automatic controls. At present virtually every machine tool builder in this country is producing machines that are or can be equipped with automatic gaging.

On the other hand, if circumstances require that existing machines be utilized when automating or integrating a particular process, it will be necessary to consider whether these older machines are suitable for automatic gaging. If the machines are not capable of adjusting to the very small increments that are sometimes required, it is foolish to spend money in the expectation that these machines can give high performance.

In such a case, it is generally more desirable to locate fixture-type gages in the machine area so that the operator can periodically check the parts being made and can adjust the machine manually. Automatic inspection machines can be placed at the end of the line through which all piece parts will be passed.

In this general discussion of automatic and machine control gaging, it has been impossible to consider fully the requirements of any particular application, or to specify what type of gaging should be chosen for a certain set of conditions. But even though definite specifications are possible only when an entire array of engineering factors has been evaluated, yet there are characteristics within the family of automatic gaging equipment which can serve as guideposts to indicate how, when, and why automatic and machine control gaging can be applied for maximum benefit.

From a paper entitled, "Automation and Machine Control Gaging" presented at the Annual Machine Tool Electrification Forum sponsored by Westinghouse Electric Corp. in Buffalo, April 1956.

WATCH AUTOMATION

By GEORGE G. ENSIGN
Director of Research
Elgin National Watch Co.

RATHER RECENTLY this thing called "automation" has appeared on the manufacturing technical horizon. We, like you, heard of it and inquired: "What is it?"; "How does it work?"; "Where do we buy some?"; "Is it true that someone is making pushbuttons that when operated could manufacture watches?" During this period of quandary, when the word automation could not be found in the dictionary, Elgin was paying close attention to this new field, and like you, was trying to understand its meaning and trying to determine what automation could do for us.

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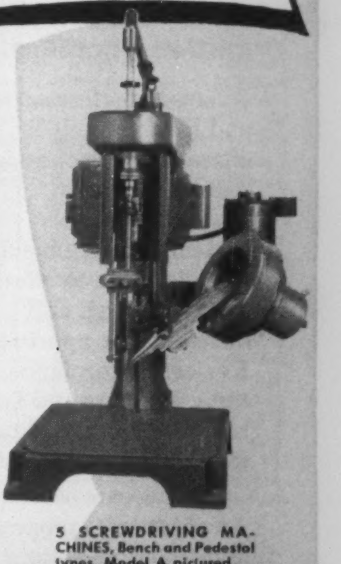

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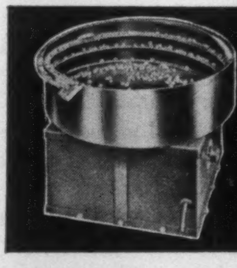

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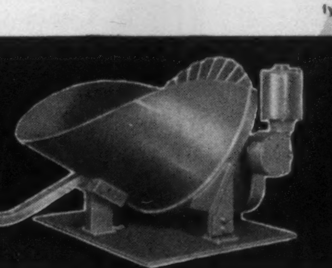

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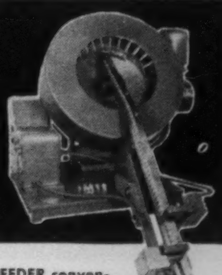

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ingenious and efficient manufacturing operations so far designed by man. We were told that this exemplified automation. That day some of us first understood exactly what the word automation meant. It means making things, engine blocks or other things, basically the way that we made the watch plates at Elgin 52 years ago. Some of us then realized that automation simply means the substitution of physical memory and effort for human memory and effort in the control of a manufacturing process.

You might infer from these comments that I take a smug attitude that says "So what—it's old stuff, let's not get all excited about this thing". Not at all. Let's go behind that basic definition and see what the word automation really means today.

In 1904 Elgin built an ingenious automatic plate-making machine comparable in miniature to the automated engine block machine of today. The engine block machine works efficiently and economically —ours did not. Elgin's automated plate machine was economically unsound in 1904, not because it was inadequately designed but because other things essential to this process had not yet been developed. Should we therefore say that automation is old stuff? Naturally not. Automation is merely a modern concept of an idea that your dad and my dad had in the back of their minds while they were groping for a way to do a job in a more efficient manner—just as you and I are groping right now for a better way to do our jobs.

Then perhaps we should redefine the word "Automation". Previously I said that it means the substitution of physical memory and effort for human memory and effort to control a manufacturing process. That is a little too general. Doesn't it really mean the application of modern technical knowledge to make manufacturing processes less dependent on human memory and effort?

In 1904 Elgin's engineers had little knowledge of memory and effort devices other than cams to control that automated plate-making machine. Today engineers have at their call a myriad of devices—hydraulic, pneumatic, magnetic and electronic mechanisms, mechanical and electronic computing devices, wire, tape and disk recorded programs, and programs laid out on punch cards. Today we and you are studying all of these systems and perhaps others not enumerated, to see where and how we can best put them to work for us. A vast and exciting field of engineering is opening before us. But let's remember that it is only another logical "next step". We find that there is a temptation to over-apply this concept of automatic control. There are still areas in manufacturing where we are not yet ready to apply automation, but often tremendous improvements in efficiencies can be made in these areas by the application of some of those sound, old-fashioned ideas of making a better tool or a better arrangement of a job to permit an operator to work more effectively.

Suppose we consider the assembly of a watch for a moment. The number of intricate and precise operations that must be performed to put this tiny machine together is rather tremendous. The parts are small and easily damaged. Adjustments must be made to fractions of a thousandth of an inch. Until recently, these operations were performed in substantially the manner that the first Elgin watch was assembled. Then during World War II we learned many things about more efficiently assembling a delicate mechanism, when we had to conserve every man-hour. Recently we have applied those war-time techniques to the production of our commercial product. Assembly jobs have been streamlined. Work is now carried to and from the operator on a conveyor. Many ingenious and very costly tools have been developed to assist the operator in performing his task.

As a result, our in-process inventories have been reduced to less than 5 per cent of what they were previously. Efficiency has been improved by a factor of more than 4 to 1. Should we have waited until a completely automatic watch assembly machine was developed? No! It is entirely possible that automatic watch assembly, although exciting to think about, may never be accomplished. We simply applied good, sound engineering knowledge and judgment to modernize an old process and reaped our rewards accordingly.

I could cite case history after case history where we have done exactly the same thing with other manufacturing processes in the last few years — the assembly of escapement jewels in the watch lever, the assembly of that most delicate watch part, the hairspring and its associated parts, the assembly of the watch balance, etc.

We dream that perhaps some day we may take steps to automate these operations, but today we do not have sufficient new technical knowledge to permit us to even know where to start the job. As I mentioned before — most of our operations are performed on the threshold of impossibility.

What I am trying to say here, is that it's time we step back a little and take another look at Automation — that we start viewing it not as the revolution which it is usually conceived to be, but rather as an evolution, simply a refinement and improvement of production methods which have been developing slowly but surely since the onset of the Industrial Revolution.

I am reminded of the time several years ago when the manager of a new plant in the Chicago area asked me to help him with a problem. Part of the magnificent new equipment in this completely automated plant was a series of small boilers which turned on, one at a time, completely automatically, to provide increased steam pressure as needed. When the need was satisfied, the boilers shut off one at a time.

It was beautiful. Layout, lighting, production flow — everything was arranged to make maximum use of automatic devices that would speed manufacturing and reduce labor costs.

I congratulated my friend on his achievement, whereupon he shook his head.

"Yes," he said, "it's wonderful. At our old plant we had 75 production workers and 5 maintenance men. This new plant is so efficient that we require only 5 production workers and 75 maintenance men!"

From a talk entitled, "Automation Revisited" presented at the Automation Conference at Armour Research Foundation of Illinois Institute of Technology in Chicago, Feb. 1956.

LINE PRODUCTION SAVINGS

By RICHARD MUTHER
Management Engineer
The Vendo Co.

PROBABLY the greatest single cost reduction contributed by plant layout that comes to any production facility is when it converts to line production. Many of our plants start right out with a production-line type of layout. In fact, here in Detroit—often referred to as the home of production line techniques—there are some manufacturers who never think in terms of job-shop layouts. For them, layout cost reduction lies in making more automatic their handling, banking, and integrating of materials.

Still, the conversion from process-type fabrication (where all machines of a given kind are located together) and from fixed-position assembly (where a complete assembly is built up at one place) is where big savings lie. This can bring a real cost reduction.

Our plant is a combination of these layout types so we are constantly on the lookout for operations which can be performed adjacent to each other, even if it involves only two or three operators in a sequence within a process-type department. For example, we might have a series of press operations, then a grinding operation, and finally paint and assembly. If the grind is necessary, we try to

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do it right after the press operations or right before paint—even if it means doing it in the press department or at the paint hanging station. This is not a case of combining operations. It is a case of relocating the operation workplace to reduce hand handling and transportation. Thus, we try to lay the piece aside where the next man picks it up—or where it will roll or slide to where the next man can pick it up easily.

Such a change must justify its cost, of course. This involves quantity, balance and continuity. There must be sufficient quantity or volume of production to pay the cost of setting up the line. Each operation, or operator in the sequence must be made to balance out at about the same amount of time—or provision made for other use of any significant amount of idle time. The operations must be technically sound, the in-flow of materials must be assured, and other precautions must be taken to be sure the operations are not interrupted.

We find that whenever we can afford to move toward line production we pick up savings that never appear in direct labor. Material handling is reduced appreciably; scheduling and dispatching is greatly simplified; supervision and training are easier; and other advantages accrue.

From a talk entitled, "Plant Layout's Contribution to Cost Reduction" presented at the Production Management Conference of American Management Association in Detroit, March, 1956.

USES OF COMPUTERS IN PRODUCTION

By C. R. DeCARLO
Director of Applied Science Division
IBM Corp

THERE ARE many reasons for adopting computers to help solve problems in production, inventory, and other industrial operations. Perhaps they can be summed up in the statement that there are several areas of dissatisfaction in production and inventory management which thus far have defied the efforts of man to exercise rational control over them. The electronic computer, with its dramatically demonstrated ability to perform complex mathematical computations and to solve exceedingly profound physical problems, has generated a great hope in production management for its use in this area.

Computer Abilities

To Handle Large Volumes of Information: Certainly the information required to describe manufacturing processes, record production, publish schedules, maintain piecework-rate tables, manufacturing specifications, etc., implies the need for extremely high reading and writing speeds. The computer of today, reading and writing at better than a million characters per minute, can scan and publish enough information to describe properly even the largest production or supply system.

To Handle Many Variables Simultaneously: Major characteristics of production and inventory problems are the occurrence of hundreds, even thousands, of variables each interdependent and necessary. There are examples of a typical cost equation for one product, representing a combination of yields and process costs, which require several printed pages. These equations represent the fact that each section of the process is itself a variable and must be entered accordingly. When these variables are combined with those describing inventory and market or forecast, the total number of variables can become enormous, as in typical scheduling problems.

To Enumerate Possible Actions: Most scheduling operations are combinatorial in nature. Thus, to schedule a set of products through a group of operations is equivalent to selecting a combination whose elements are the amount of time spent on any one product on any one machine, with certain combinations not allowed because of precedence relationships in processing. Now, if for each combination, i.e., detail schedule, one can associate a function such as a typical cost function, the problem becomes one of selecting that combination which will give, for example, minimum total cost. In this case, the cost might be the sum of all the products and operations.

However, in even simple idealized cases, and assuming the fastest machine available, it would be impossible to enumerate completely all possible combinations in cost. Thus, there is a need to develop a mathematics which can short-cut the enumeration problem. Combinatorial mathematics to date is a new field, probably for the principal reason that until the advent of the electronic computer the mathematician has had no laboratory in which to test his combinatorial theories. However, in real life, production and inventory problems and their combinatorial nature will dictate that both mathematics and machines be improved to handle this important phase.

In addition to pure combinatorial enumeration, enumerations also can be considered where answers are being provided to analytic problems. Thus, for example, in solving a typical problem of allocating machine capacities against a set of orders, the computer can actually list the possible choices of product mix. Thus assuming that a mathematical device such as linear programming is used, the various choices can be listed and the associated function to be minimized observed. Certainly the heart of decision making in any form is acquiring data, digesting and processing it, enumerating choices against a set of criteria and choosing the one that best meets that set. In this sense, the computer will enhance management's intuition by broadening the scope against which choice can be made.

Production Scheduling

Probably one of the most complex production applications being done on an electronic computer occurs in the aircraft industry where the IBM Type 701 is used for production scheduling and control of shop orders. In this instance, after a contract is procured, a master schedule is established stating the number of ships, rates of production and number of days a given rate is to be effective. The 701 prepares a base schedule which shows, by shop calendar date, the exact day each ship is due at a given station or line position on the production line. This schedule may be revised as manufacturing schedules accelerate or retard. Following computation of the base schedules, ships of a given contract are grouped into lots for manufacturing. Thereafter, all fabrication and assembly parts are scheduled to the first ship of the lot.

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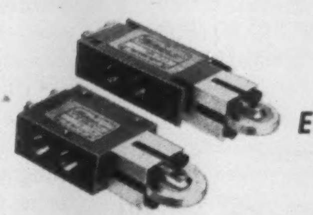
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engineering and manufacturing changes, as well as inventory information.

This change file is processed with the main tape file and a completely new revised main tape file is written. Calculations are made during this processing. Engineering and manufacturing changes are entered in the main file. Part usage by assembly and plane is extended and summarized by lot and contracts. Net quantities are computed for each lot in each contract. Previous part orders are examined and if a need for a part is determined it will be scheduled and written on an output tape, to prepare a shop order later. A scheduling operation is performed and the need for part orders on succeeding lots is determined. The machine will continue to schedule quantities for each lot until a lot is reached which does not require the present initiation of shop orders. Finally orders are written for those parts which require replacement.

Perhaps the most important concept illustrated by this use of the 701 lies in the consolidation of many files (all basically related to the part number) into one file. The weekly processing of this file against one change-file representative of all types of change, creates a variety of output data and automatically revises the main file to current status. Thus engineering, manufacturing, inventory and planning information are all treated simultaneously for better management.

Machine Load Forecast

At IBM we have used the 701 for calculating the machine load and raw-material forecast for one of our manufacturing plants. Basic to this application is the fact that the inventory-control system is based upon an ordering cycle. Thus, the inventory position of a part as of a particular manufacturing day is analyzed by the machine.

Parts on order are added to the present stock, and from this sum the amount of back-order parts is subtracted. This quantity is divided by the average daily usage for the particular part to give the normal production time interval covered by the present inventory position. From this is subtracted a number of days equivalent to the protective stock or minimum stock level.

This, then, is the actual production time interval before replenishment is required. This interval, expressed in days, is added to the current manufacturing calendar date to determine the first actual stock date; i.e., the date at which new parts should be available. The replenishment interval is then computed by dividing the economic lot size by the average usage.

Parts Routing

The engineering part history, or part routing, is now introduced. This is equivalent to operational estimates for machine tools or conversion processes, and labor and raw material. Typical routing operations for each part include setup and production rates, raw material per part, transit times, etc. The 701 examines the last operation used in the part routing. The hours required in this operation for the particular part are computed; e.g., multiplying economical lot size by hours per piece and adding setup time. These hours are rounded to the next highest day. The days spent in the operation are then subtracted from the first stock date for the part to determine the start date for the part in the operation. The replenishment interval is now added to this start date to determine each start date for the part in the given operation for the total scheduling period. Thus a series of start dates for a particular part through a particular operation is obtained. The 701 determines when a start date falls beyond the range of terminal day of the schedule period, terminating the computation.

Returning to the first operation start date, the 701 subtracts transit time for the part and examines the next preceding operation. Load computations are made, the replenishment interval added, and the process is repeated until the initial operation for the part is reached. Parallel with this operation, load totals for each operation are accumulated. Also raw-material computations are made and summarized by time period.

In this particular application, the effect of various machine routings to accomplish a particular set of manufacturing properties can be arranged as part of the computer schedule. The effect of routing upon shop loading can be examined on the computer. Also, the effect of complete and partial ordering can be examined to the limit of time available upon the computer.

Production Management Tool

One of the ultimate objectives in using the computer as a production management tool will be the inclusion of the effect of chance upon schedules. To this end, an experimental application was programmed on a Type 701 to determine the feasibility of scheduling a precision manufacturing operation in a shop. Jobs in the shop were rated on a priority basis based on due date and the amount of work yet to be done.

A group of jobs was chosen and these jobs scheduled, taking into account the chance variables of machine breakdown, operator performance, rejection rates, manpower availability, and machine capacities. Each of these variables was brought into the solution by the use of density functions and random-number generation techniques. Therefore, while the variables were random, their impact could be statistically predicted. For each permutation the schedule was computed several times with an average evaluated cost. Following this, other groups were scheduled in similar fashion, finally selecting that set of schedules which assured minimum cost.

Measuring Production

The importance of using statistical methods in establishing productivity measurement lies principally in the better control the production engineer gains, as well as allowing for better prediction in scheduling labor and shop facilities. Generally, the production and industrial engineer has made little use of statistical and probability methods in his work. One of the reasons for this is the tediousness of the calculations necessary to establish statistical relationships. In this instance, the electronic computer adds a really new and powerful tool to the production engineers' work.

An important application of mathematics on computers for production engineering has been reported by Dr. Salveson of General Electric Co. This is the problem of assembly-line balancing, in which it is desired to establish work stations along the assembly line in such a way as to minimize idle time at each work station. In general, the component parts must be assembled in some specified sequence, obeying precedence relationships, with the elemental work tasks being defined by engineering standards. The problem is to group these tasks into work stations, consistent with the precedence relationships, in such a way that the sum of the idle time at each work station will be a minimum. Mathematically, this problem was solved through the use of linear graph theory, and a combinatorial approach to convex sets. This is an excellent example of a problem which is both discrete and combinatorial.

Dr. Salveson also points that further refinement is required in establishing standards used to describe elemental work tasks. He summarizes the importance of this: "It appears certain that the present single parameter system (mean) for motion-time systems is not meaningful for refined methods of programming. Instead, we shall need at least a two-parameter system (mean and variability) for short stable periods, together with regression coefficients or other measures of change in relation to such factors as quality of parts and tools, ambient temperature, season, hour, day of week, etc. Given these it would be possible to develop a procedure whereby standard task time is flexibly established."

Future Possibilities

What has been accomplished to date gives promise of a bright future for the use of the electronic automatic computer in production engineering. In common with the use of the electronic computer will be the development of mathematical and scientific methods in production engineering. It is to be hoped that universities will increase the already strong interest in the problems of production management and management science.

Certainly the industrial engineering departments and the mechanical engineering departments of most of the major universities have, or will undertake the teaching of applied mathematics as an engineering tool. For, without the precision that is implied in the mathematical treatment of a problem, solutions of complex production and inventory problems would be indeed hopeless, even in the presence of the largest and most powerful computer man will ever be able to build.

From a paper entitled, "Computers and Production Engineering" presented at the Annual Meeting of ASME in Chicago, Nov. 1955.

"... but we are a peaceful nation, and far more important is the necessity to improve our technology in order to increase our standard of living. The new abundance which is possible through greater automation is one of our major weapons in waging peace. According to our company's estimates ... the United States will require about 40 per cent more goods and services by 1965 with only 14 per cent more people in the labor force. To produce 40 per cent more goods and services with only 14 per cent more people, either everyone must work harder and longer—which is neither a realistic nor a good solution—or industry must be encouraged to invest in more productive machinery and methods. Faster progress in the newer field of automation seems to us to be the only available solution to this problem, particularly in situations where we have exhausted the known economic possibilities in the more familiar field of simple mechanization. . ."—
Ralph J. Cordiner, president, General Electric Co.

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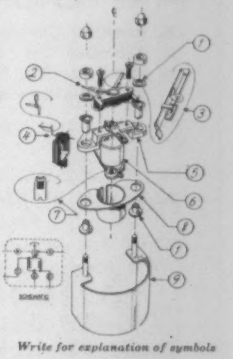

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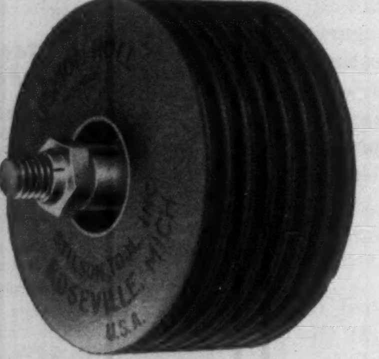

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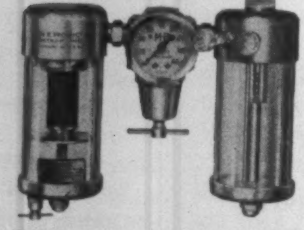

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AUTOMATION patents

Copies of patents are available at 25 cents each from the Commissioner of Patents, Washington 25, D. C.

Components

REMOTE CONTROL MECHANISM FOR ADJUSTING ROTARY CUTTING TOOLS

Two cylinders acting through ratchet wheels adjust a rotary cutting tool and permit control from a remote point. Patent 2,734,402 by Joseph H. Hoern.

INSTANTLY SWITCHING REVERSIBLE MOTOR

Reversible self-starting single phase alternating current motor has two windings with phase displacing means and speed and direction responsive disconnecting means. Phase displacing means is disconnected above a set speed, and the winding opposing existing rotation cannot be energized until speed drops below a second predetermined speed. Patent 2,740,931 by Sol London and Richard D. Kirk, assigned to General Electric Co.

IMPULSE-STORING DEVICE FOR USE IN SIGNALLING SYSTEMS

Contact fingers in radial arrangement are disposed on one side or the other of an annular guide member through which they pass. Means is included to position the fingers in response to impulses and to read their positions later. Patent 2,737,648 by Willy Lohs and Walter Paul, assigned to Siemens & Halske Aktiengesellschaft, Munich, Germany.

• • •

Controls

INJECTION MOLDING MACHINE WITH AUTOMATICALLY-CONTROLLED WEIGH-FEEDER

Electric means feed material to a scale and supply weighed charges from the scale to the ram. An electric compensating circuit, controlled by the position of the ram at completion of its stroke, automatically controls the weight of successive charges. Patent 2,736,923 by Warren J. Schieser and John F. Kelley, assigned to the Exact Weight Scale Co.

AUTOMATIC CONTROL MECHANISMS FOR MACHINES WITH INTERDEPENDENTLY OPERATING PARTS

A machine part to be operated is connected to a driven shaft through a lever actuated clutch. Balls of two different diameters are circulated through a circuitous pathway and past the clutch lever so that the balls of larger diameter actuate the clutch at selected intervals. Patent 2,734,604 by John G. Soave, assigned to Waldes Kohinoor Inc.

SURFACE LEVEL CONTROL IN A COMPACT SOLIDS BED

Granular solids are fed through an orifice with the use of a first gas stream into a chamber from which the solids are being drained. Pressure required to pass a second gas stream through the material regulates flow of the first gas stream and, thus, supply of solids. Patent 2,737,294 by William L. McClure, assigned to Sun Oil Co.

◆ ◆ ◆

Handling

APPARATUS FOR THE CONTINUOUS TREATMENT OF CLOTH

Speed of one set of feed rolls is varied with respect to speed of a second set of rolls in the continuous wet treatment of cloth. Electric circuit controlling the speed adjustment is completed through the wet cloth when it moves into engagement with two contacts. Patent 2,739,468 by Harold R. Wilcox, assigned to Riggs & Lombard Inc.

ANNULUS VIBRATORY FEEDER

Device for feeding material uniformly around an annular path comprises a plurality of independent feeder troughs each with means effecting vibratory reciprocation to impart positive conveying action. Patent 2,737,289 by William F. Peters, assigned to Syntron Co.

CONVEYOR SYSTEM FOR ADVANCING AND DIVIDING A SERIES OF ARTICLES TO VARIABLY PRESELECTED SEPARATE CONVEYORS

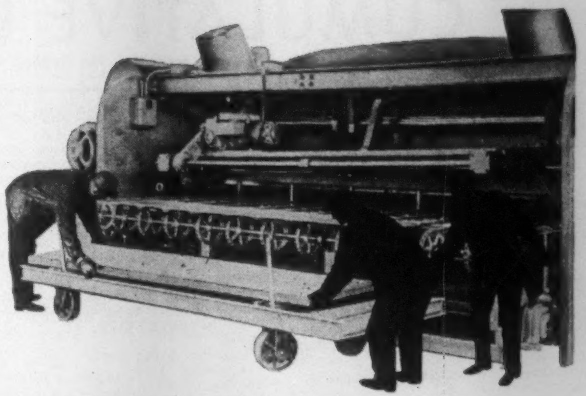
Articles traveling on a conveyor are distributed by a pivoted section of that conveyor to conveyors positioned vertically adjacent the path of travel of the swinging end. A selectively adjustable switch mechanism determines the sequence of deliveries. Patent 2,739,694 by Charles T. Hatch and Stanton R. McKim, assigned to Union Steel Products Co.

◆ ◆ ◆

Testing

TESTING VACUUM IN VIALS

Stoppered, metal sealed, evacuated vials are tested for proper evacuation by means of high voltage, high frequency discharges through the vials which cause a glow in properly evacuated vials. Absence of glow when a defective vial interrupts a regular light source causes a phototube to actuate a reject mechanism. Patent 2,734,628 by Earle G. Schlayer, assigned to American Cyanamid Co.



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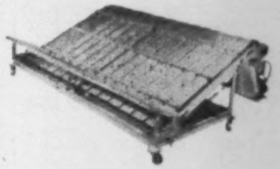

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